The

ENGINEERS' DIGEST

A World Review of

DESIGN & PRODUCTION · RESEARCH & DEVELOPMENT

VOL. XXI No. 2 FEBRUARY, 1960

620 X-1

ARCHDALE

Radials

FULL RANGE OF TYPES
FOR LIGHT, MEDIUM
AND HEAVY DUTY
INCLUDING MECHANICAL
AND HYDRAULIC "PRE-SELECT"
MODELS UP TO 12 FEET
SPINDLE RADIUS

Photograph by courtesy of
MOLINS MACHINE CO., LTD
shows light and medium duty types

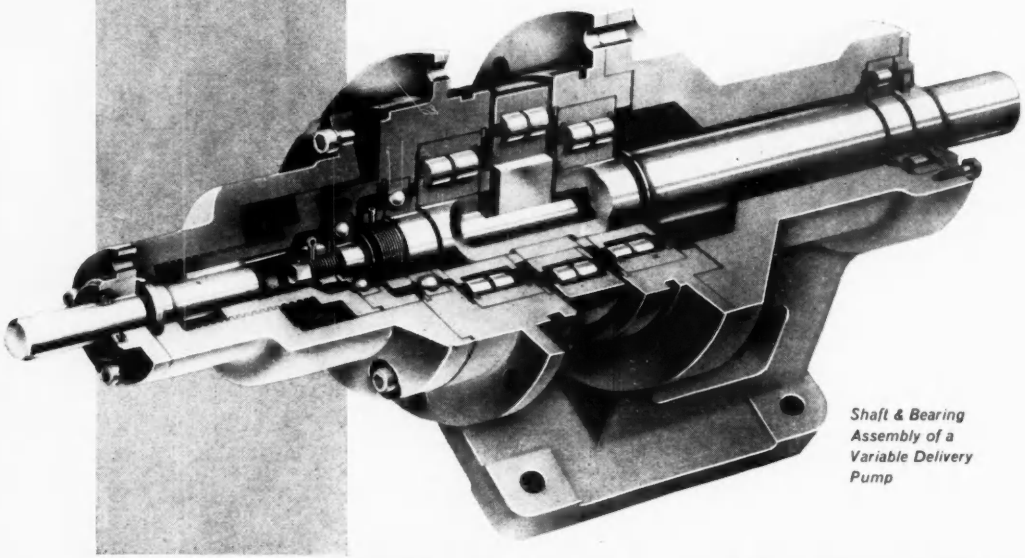
✳ AN ASSURANCE OF HIGH DRILLI

JAMES ARCHDALE & CO., LTD
Registered Office: LEDSAM ST., BIRMINGHAM, 16
Telephone: Edgbaston 2276
Works: BLACKPOLE WORKS
WORCESTER
Telephone: Worcester 27081 (6 lines)
A MEMBER OF THE STAVELEY COAL
& IRON CO., LTD. GROUP
Sole Selling Agents:
ALFRED HERBERT LTD. COVENTRY

built to last longer

because they are engineered and manufactured by FRASER and possess the combined qualities of sound engineering design and manufacturing skill. Stringent tests of materials quality, precision machining and constant supervision throughout manufacture, ensure that FRASER pumps stand up to tremendous hard usage. FRASER PUMPS for single high pressure delivery, combined or independent low and high pressure delivery or infinitely variable delivery have a pressure range of up to 6000 p.s.i.

FRASER pumps last longer — much longer.

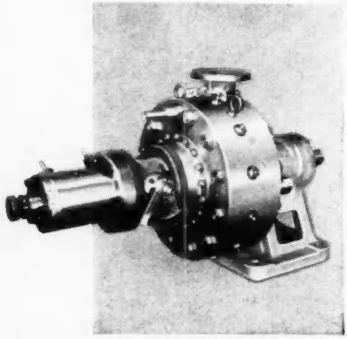


Shaft & Bearing Assembly of a Variable Delivery Pump

CIRCUIT DESIGN SERVICE

to meet specific needs. FRASER'S qualified engineers will advise and design your hydraulic circuit.

FRASER



FIRST AND FOREMOST IN HYDRAULICS

ANDREW FRASER & CO LTD

29 BUCKINGHAM GATE LONDON SW1

PHONE: VICTORIA 6736-9

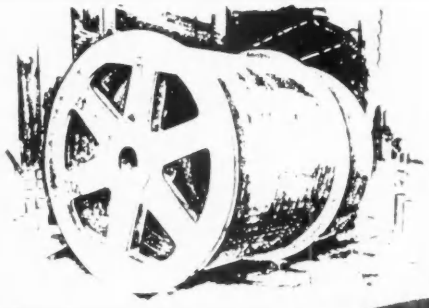
P.2274

IRON CASTINGS UP TO 20 TONS

ASHMORE'S GREY IRON AND HIGH DUTY IRON CASTINGS

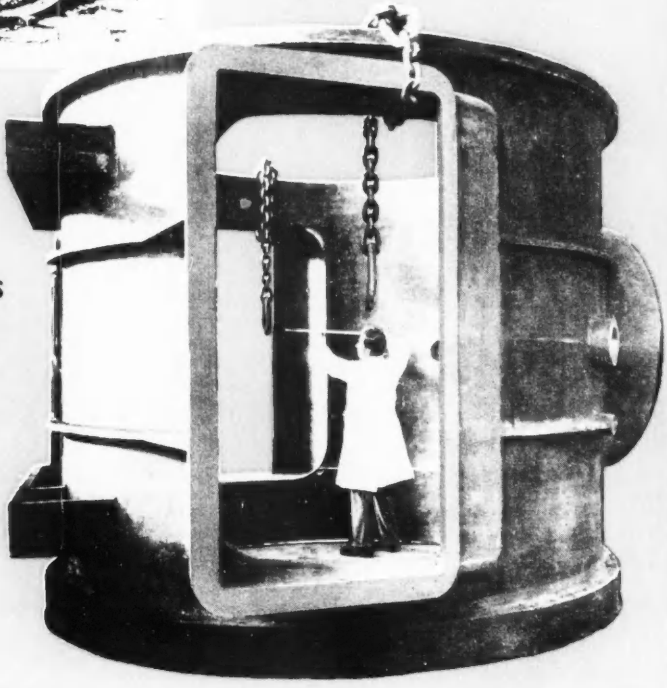
Ashmore's high duty iron castings are produced in many grades to meet specific requirements, whether for heat, wear or corrosion resisting applications and conform to B.S.S. 1452, grades 10-26. Capacity is available for producing castings up to 20 tons weight or 13 feet diameter, by modern methods and processes.

Moulds and cores are produced by hand and machine moulding and loam moulding in green sand, oil sand, sand slinger production and CO_2 processes.



Main winding rope drum for blast furnace equipment—10 tons in weight.

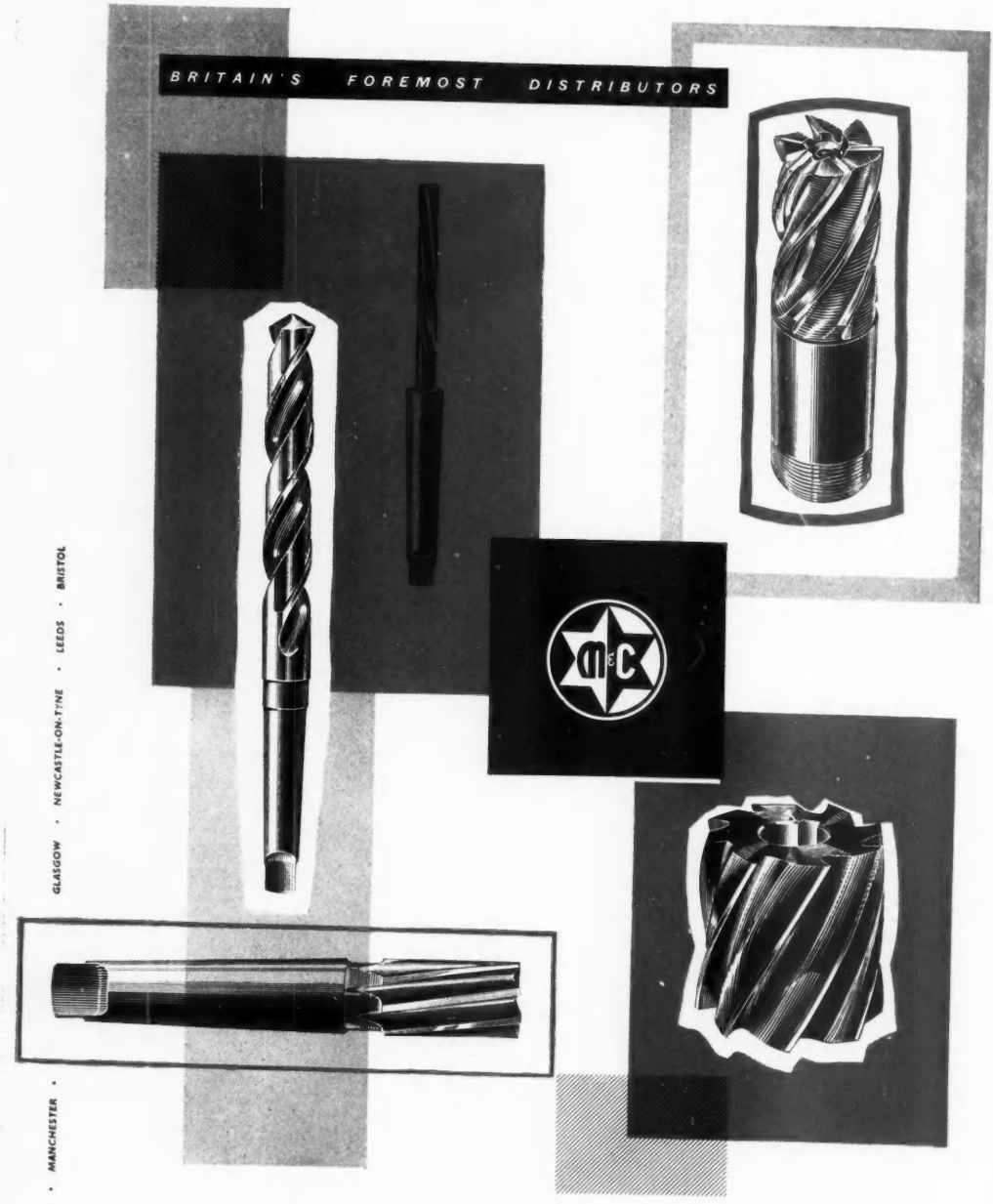
QUALITY AND SERVICE
ASHMORE'S IRON CASTINGS



A 13½ ton evaporator casing cast in high duty iron.

ASHMORE, BENSON, PEASE & COMPANY LIMITED
STOCKTON-ON-TEES AND LONDON
MEMBER OF THE
POWER-GAS GROUP

373


BRITAIN'S FOREMOST DISTRIBUTORS
BIRMINGHAM • LONDON • MANCHESTER • GLASGOW • NEWCASTLE-ON-TYNE • LEEDS • BRISTOL
of engineers' small tools
Monks & Crane Ltd
SM/MC5140

CONTENTS

	Page
The Minidigest	4
Business Notes	10
Contracts	14
Personal	18
News Round-up	24
New Technical Books	30
Latest Industrial Literature	32
The Blue Pages	73
Titanium-Platinum Electrodes for Cathodic Protection in Sea-Water	81
Improved Pulsed-Light Source and Motion-Picture Projector	83
An Improved Sublimation Method of Temperature Control of Hypervelocity and Space Vehicles	87
Turning Metals with Vibratory Cutting Tools	89
The Planche Four-Cylinder Engine with External Combustion Chamber	92
The Suitability of Various Gases as Working Media for a Nuclear Reactor-Gas Turbine Combination	94
Improved Methods of Producing Metal Fibres	96
Strain-Gauge Measurements over Long Distances	97
British Industrial Developments	101
Additional Abstracts	113
New Materials, Processes, and Equipment	121

The ENGINEERS' DIGEST

A World Review of DESIGN & PRODUCTION · RESEARCH & DEVELOPMENT

VOL. XXI No. 2 FEBRUARY, 1960

EDITORIAL AND ADVERTISING OFFICES:

GREAT BRITAIN
120 Wigmore Street, London, W.1.
Telephone: WELbeck 9357 & 6263

U.S.A.
366 Madison Avenue, New York 17, N.Y.
Telephone: MUrray Hill 2-8865

FRANCE
102 Rue Amelot, Paris (XI^e^)
Telephone: VOL. 29-19

ITALY
Via degli Orombelli, 13, Milan
Telephone: 23.16.72

Annual Subscription Rates:
£2 2s. 0d. in the Sterling area, $7.50 in the Dollar area

Printed in Gt. Britain by THE ALCUIN PRESS, Welwyn Garden City, Hertfordshire, and published monthly by the proprietors, ENGINEERS' DIGEST LTD., 120 Wigmore Street, London, W.1.

A SELECTION OF TECHNICAL BOOKS FROM THE FAMOUS **PITMAN** LIST

FUNCTIONS OF COMPLEX VARIABLES
By Philip Franklin.
This book is outstanding for its clear and precise explanation of a branch of mathematics which has often been obscured in a haze of highly abstract concepts. Logical and essentially complete, its purpose is to introduce the reader to the general properties of an analytical function of a single complex variable. Price 25/- net.

SURVEYING
By A. Bannister, M.C., B.Sc., etc., and E. S. Raymond, B.Sc., etc.
A new textbook for the examinations of the H.N.C. and Diploma in Civil and Structural Engineering and in Building; I.C.E. Part II; R.I.C.S.; Dip.Tech and Degrees in Engineering. It provides a direct approach to the subject and covers modern instruments and techniques. Engineering Degree Series. Price 45/- net.

A DIGEST OF ELEMENTARY CHEMICAL THERMODYNAMICS
By D. Shireby, A.R.I.C.
This book provides an elementary account of chemical thermodynamics suitable for students in the earlier years of technical college and university courses and in the sixth forms of grammar schools. The mathematics involved are fairly easy and the text includes many worked examples. Price 20/- net.

WINDING AND TRANSPORT IN MINES
By John Sinclair, M.Eng., etc.
This new book deals in a comprehensive manner with all the new developments in winding and transport in mines, together with the older techniques still in extensive use. It forms an essential textbook for Degree, O.N.C., H.N.C., Diploma in Mining, and A.M.I.Min.E. Price 60/- net.

ELECTRONICS
By A. T. Starr, M.A., Ph.D., etc.
2nd Edition.
Specially written to cover the requirements of the syllabus for the subject of "Electronics" in the University of London B.Sc. Engineering Degree, this book will also prove valuable to students taking other courses at this level and such professional examinations as those of the I.E.E. and the British Institution of Radio Engineers. In this second edition there is a fuller description of semi-conductors and transistors in the light of recent advances. High-frequency valves such as the klystron and travelling wave tube have been introduced and recent examination questions have been added. Price 35/- net.

POWER ECONOMY IN THE FACTORY
By J. C. Todman, F.C.W.A.
A reliable and up-to-date book for cost clerks, works accountants, engineers, and businessmen showing how running costs can be reduced and production improved, with indications of common faults in the organization and operation of mechanical labour. Price 12/6 net.

From all Booksellers

PITMAN Parker Street, Kingsway, London, W.C.2.

The MINIDIGEST

Capable of withstanding temperatures between −180 and +250°F, a new **radiation-resistant thermoplastic resin** has been developed by the Sales Service Laboratory of the Plastic Sales Division of the Phillips Chemical Co., of Bartlesville, Oklahoma. The new material, which is a rigid polyethylene, is stated to have the highest hydrogen content of all plastics, resulting in the ability to slow down neutrons more effectively than any other similar material and making it more suitable than water and concrete installations for protection from neutron-radiation damage.

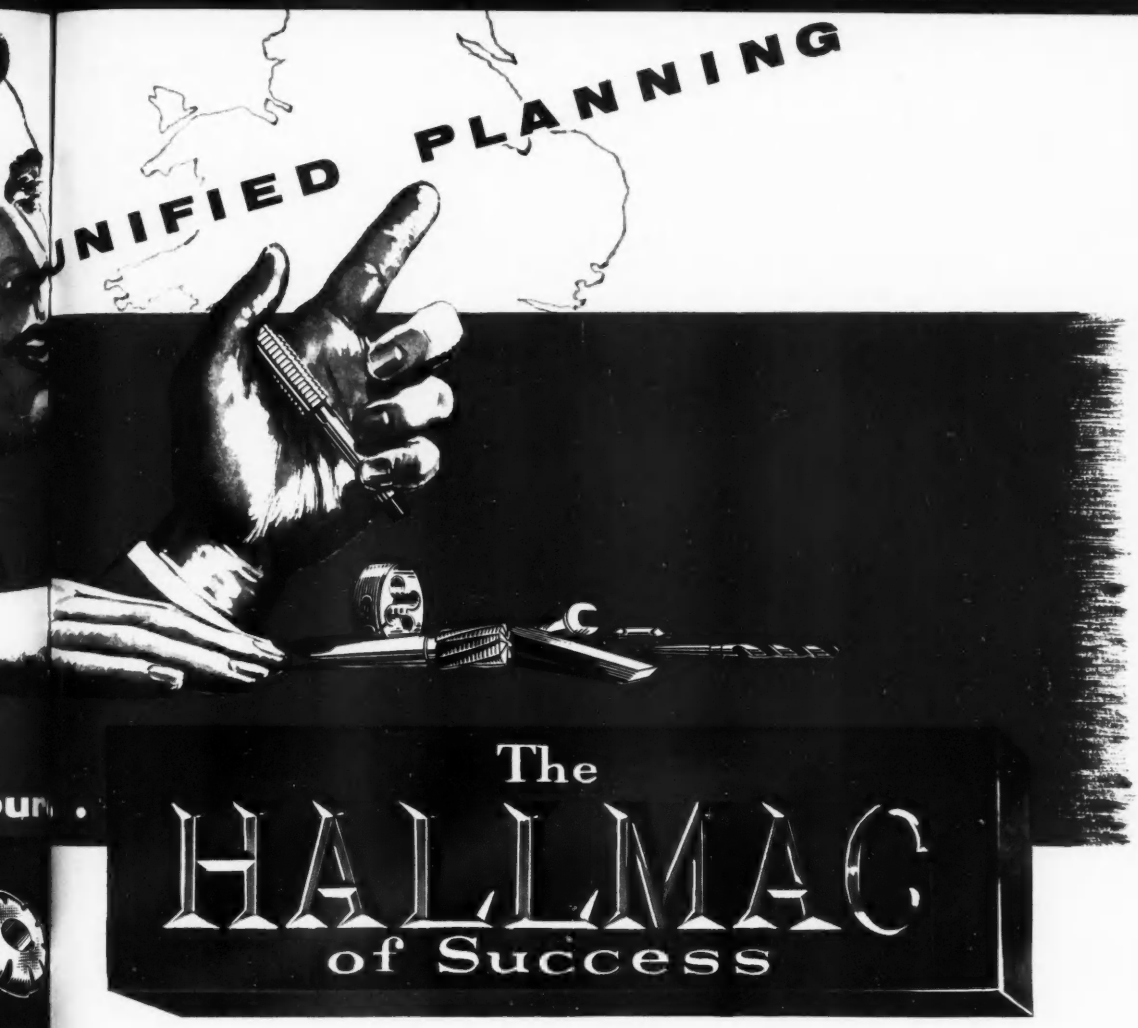
* * *

In an article in *Kunststoffe* (combined with *German Plastics Digest*) for December 1959, in connection with the **influence of fillers on the structure and electrical properties of plasticized polyvinyl chloride compounds,** it is shown that electrical measurements have established that fillers added to these compounds tend to absorb the plasticizer. They also absorb saponification products and other ions, thus making it possible to improve electrical properties. The results of measurements of the loss angle, as well as stability, electrical, and water-storage experiments, seem to indicate that the filler particles, which differ in size, are randomly embedded in the tangled molecules of polyvinyl chloride. The forces of attraction between the filler particles and their surroundings are only very slight, and the remaining interstices (about 10^{-7} cm) are not interconnected if the filler content is low and its distribution is even.

* * *

According to a note in *Product Engineering* (December 21, 1959), tests on various materials, using a simulated parachute landing involving a 14-ft drop into sand, have shown that **honeycomb materials as impact-absorbing screens for instruments and personnel** are generally superior to foamed plastics. Apparently, the rigid plastic foams become so stiff after about 60% of their thickness or depth has been used up after impact that they no longer serve as a cushion, while the semi-rigid foams, though soft enough to provide a satisfactory cushioning effect, are often so resilient that the resulting rebound is a serious problem. Aluminium honeycombs, on the other hand, exhibit very little rebound, and up to 80% of their depth is usable. However, the initial impact may be severe, owing to the solid structure of the honeycomb skin. For this reason, it is considered that the best material for the pur-

Tools from one sour
HALLMAC TOOLS LIMITE
LONDON: Suite 418, Cayzer House, 2 4 St. Mary
London, E.C.3. Telephone AVEnue 5792.
SALES MANAGERS FOR



The
HALLMAC
of Success

The most successful answer to the tool supply problem is to order all tool requirements from one source—provided that source is 100% efficient and comprehensive. Hallmac's immense stock of Engineer's Small Tools, Hand and Power Tools, and Macrome treated tools is supported by a distribution and service network that covers the whole country. This means immediate service on standard requirements; even on "specials" an *almost* immediate response. This is the Hallmac of Success, enabling you to iron out all your buying difficulties with one simple, sensible decision: Tools from Hallmac. To give you an idea of the range we cover, may we send you a copy of the latest 44 page Hallmac Stock List, now recognized as the foremost of its kind?

d Office & Depot: **P.O. Box No. 39, Macrome Road, Wolverhampton.** *Telephone* 52001 (9 *lines*)

MANCHESTER: Transport House, 1 The Crescent, Salford, Lancs. *Telephone Pendleton* 3656.

GLASGOW: Central Chambers, 11 Bothwell Street, C.2. *Telephone* CENtral 5066.

ND TOOL DIVISION OF THE BREN MANUFACTURING COMPANY

JW.Ad 4747

The MINIDIGEST

pose may well be a sandwich construction containing both honeycomb and foamed or semi-rigid plastics.

* * *

In a Japanese investigation into the **diffusion of silicon, sulphur, and manganese in liquid iron,** described in *The Science Reports of the Research Institutes of Tôhoku University* (Vol. 11, No. 5, Series A), it was found that, at low concentrations, the diffusion coefficients of these elements were from 2 to 5×10^{-5} cm²/sec, and the activation energies for diffusion were from 6 to 10 kcal/mol. With regard to silicon, the variation in diffusivity with silicon content was examined up to a value of about 20%, and it was noted that the diffusion coefficient increased with increasing silicon content both in pure liquid iron and in carbon-saturated liquid iron. It was also found that the diffusion coefficients of silicon and sulphur tended to decrease in the presence of carbon.

* * *

Details of experiments carried out in Russia in connection with the **hot-rolling of metals in a vacuum** are reported in *Stal* (No. 10, 1959). In these experiments, specimens made from iron and nickel were used and were rolled for 30 min at temperatures of 900, 1000, and 1200°C, the rolling speed in all cases being about 20 fps, and the reduction in cross-section 20%. Comparative tests were carried out under these conditions with specimens rolled in air and also in a vacuum of 1×10^{-2} and $1{\cdot}5 \times 10^{-5}$ mm Hg. The results of these tests showed that, in the case of hot-rolling in a vacuum, the scale normally associated with hot-rolling in air was almost completely absent, but that the resistance to deformation and the coefficient of friction were considerably increased.

* * *

A new **process for the separation of mixtures of powders** has been developed at Princeton University and is based on the fact that most powders have different dielectric constants. In this process, the mixture is allowed to flow down an inclined trough, while electrodes located above and below the trough produce a non-uniform electrical field. The field strengths are adjusted to cause one powder constituent to move to the higher side of the trough, leaving the other along the lower edge. The process has already been used to separate sodium dichromate

Factory Fire Protection

In 1960 it is evident that the Government and, in fact, all responsible authorities, are intending to take strong action to ensure the provision and maintenance of adequate fire protection in all business and factory premises—necessitating the installation of Fire Safety Equipment of an accepted and approved standard. This will undoubtedly affect all industrial concerns and we invite those who may be in doubt about their fire protection to consult us on their problems. Within the wide range of "PYRENE" Fire-fighting and Fire-detecting Equipment there are appliances to meet every present-day fire risk; therefore we are in a position to offer impartial advice.

Furthermore, we have for many years operated a nation-wide *Maintenance Service* which provides regular inspection and certification of all fire extinguishers on subscribers' premises.

Yet another "PYRENE" Fire Protection Service, widely adopted by both large and small organizations, is our *Hire-Maintenance Plan* that covers the installation of the correct numbers and types of fire extinguishers—and their maintenance thereafter in efficient condition—for a moderate annual fee.

Pyrene TRADE MARK FIRE PROTECTION

Whatever your fire problems, be sure to consult us for free and impartial advice, entirely without obligation.

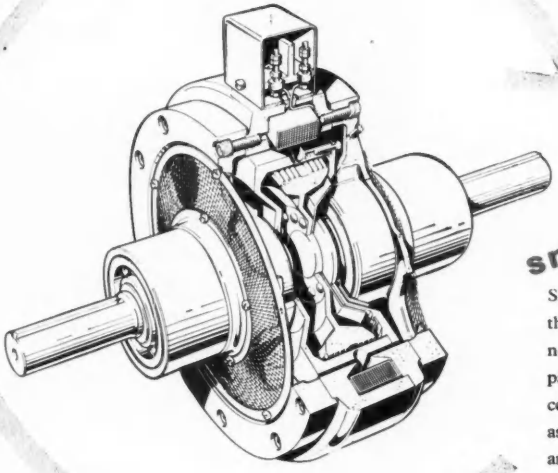
THE PYRENE COMPANY LTD

(Dept. ED2), 9 Grosvenor Gardens, London, S.W.1. *Telephone: VICtoria* 3401

Head Office and Works: BRENTFORD, MIDDLESEX. *Canadian Plant:* TORONTO. *Australian Plant:* MELBOURNE.

SMITHS

Magnetic Particle
COUPLING



smooth yet positive

Smooth as a hydraulic coupling, but without the drag, positive as a friction clutch but never needing adjustment for wear, SMITHS magnetic particle COUPLING provides accurate control of torque without complications. It acts as a coupling or brake in either direction and can be remotely controlled from any distance.

If your requirements include coupling units with torque capacities between 1/3 and 200 lb/ft, let us advise you on the application of these units in your plant.

SMITHS **S. SMITH & SONS (ENGLAND) LIMITED**

AP92

INDUSTRIAL PRODUCTS DEPARTMENT, WITNEY, OXON. Telephone WITNEY 678

The MINIDIGEST

from titanium dioxide, silicon carbide from mixtures of metallic oxides, and iron and zinc powders from silica.

* * *

Eliminating the need for the four heads with matching characteristics normally used, a **simplified television tape-recorder** developed by the Shibaura Electric Co. Ltd., of Tokyo, Japan, uses only one magnetic head, which records a complete television field in a single diagonal track of evenly spaced parallel lines across a 2-in. magnetic tape. Basically, the system comprises a cylinder, around which the tape is looped once in a spiral, and a motor inside the cylinder, this motor rotating the recording head at about 3600 rpm. The new system is stated to improve picture quality and to simplify editing, as the tape can be held stationary or reversed and its speed can be increased or decreased, as required. Furthermore, it requires the use of only one recording and reproducing amplifier.

* * *

An interesting design of **quick-acting nut**, reported in *Machine Design* (December 10, 1959) utilizes slip-grip threads which permit the nut to be slipped quickly into place and then tightened for fastening. The nut incorporates a plain bore, which is at an angle to the threaded bore and which interrupts the threads in the nut. When the nut is tilted, the smooth bore surface slides over the stud, after which the threads can be engaged and the nut tightened by tilting the nut so that the axis of its threaded hole is in line with that of the stud.

* * *

Details of a **new cutting-tool composition** containing 80% titanium carbide, 10% nickel, and 10% molybdenum, developed by the Scientific Laboratory of the Ford Motor Co., are given in *Precision Metal Molding* for January 1960. This new composition is a fine-grained material with a uniform dispersion of titanium carbide through the nickel-molybdenum matrix, the use of molybdenum ensuring dispersion and retention of the initial fine grain size of the carbide, and resulting in improved hardness, strength, and impact resistance. Comparative tests on tools made by powder metallurgy from this material indicate that their life is from about 4 to 6 times greater than that of conventional ceramic and tungsten carbide tools, and that their cost will be competitive.

Let the above tell you about the Arthur Balfour wide range of products!

FOR THE ATTENTION OF THE PRODUCTION ENGINEER!

16	1	10	4
8	15	6	7
13	2	14	5
9	11	3	12

You might care to take the attention of your Production Engineer away from pressing problems for a few moments. Let him tackle this problem . . . an adaptation of the magic square which amused the philosophers of old. A sketch of it appears in the Anatomy of Melancholia by the 15th-century painter Albrecht Dürer.

Sixteen squares are placed on the table. The problem is to arrange them so as to make the sum of figures add up to 34, whether counted up, down, across or diagonally. One solution is given here.

1	15	14	4
12	6	7	9
8	10	11	5
13	3	2	16

Where problems involving High Speed Steels, Alloy Steels and Engineers' Tools are concerned, the simplest solution is through the telephone to Arthur Balfour . . . SHEFFIELD 22071 . . . There are six lines.

STEEL & TOOLS FOR THE WORLD

ARTHUR BALFOUR

ARTHUR BALFOUR & CO. LTD., CAPITAL STEEL WORKS, SHEFFIELD, ENGLAND

BUSINESS NOTES

Tarex (England) Limited, until now sales and service company for **Tarex S.A.,** of Geneva, have been appointed selling and servicing agents for **Hasse & Wrede,** of West Berlin, and of **Strohm Maschinenfabrik,** of Schwenningen, West Germany.

* * *

Baldwin Industrial Controls, Baldwin Instrument Co. Ltd., of Dartford, Kent, announce the formation of a hydraulic servo division in order to offer industry a comprehensive service for the application of hydraulic servo techniques to problems of production and experimental engineering.

* * *

It is announced that the **Elliott-Automation Group** has purchased **Black Automatic Controls Limited,** of Corsham, Wilts., manufacturers of control-valve and pressure-regulating equipment.

* * *

B. & S. Massey Ltd., of Openshaw, Manchester, and **L. Schuler A.G.,** of Goeppingen, West Germany, announce the completion of a licence agreement, under which Massey will manufacture Schuler friction screw presses, the range of which includes presses for embossing, stamping, and hot-pressing work, as well as presses with wide frames for large components and bending work.

* * *

The Continuous Casting Co. Ltd., of Weybridge, Surrey, announce an agreement for technical collaboration with **Low Moor Alloy Steelworks Ltd.,** of Bradford, which have, over a number of years, developed their own plant for the continuous casting of stainless- and alloy-steel slabs, blooms, and billets.

* * *

J. H. Fenner & Co. Ltd. announce the formation in Johannesburg of **J. H. Fenner & Co. Africa (Pty.) Ltd.,** who plan, in conjunction with **Reunert & Lenz Ltd.,** the manufacture of a range of mechanical power-transmission equipment in the Union of South Africa.

* * *

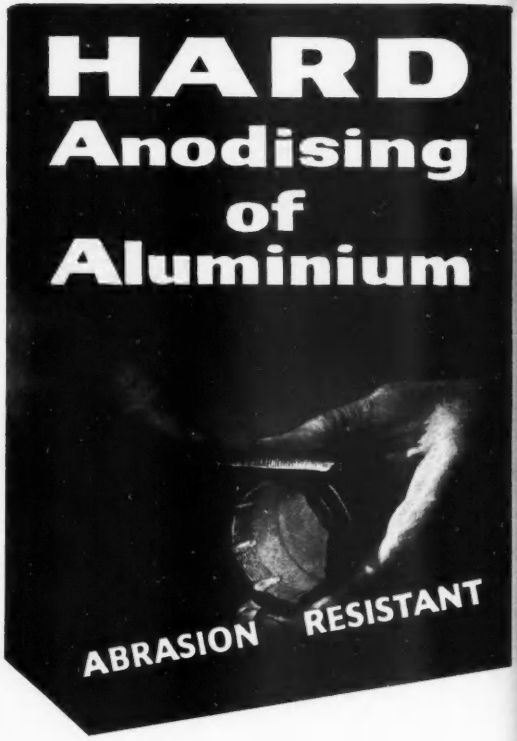
The London branch office of the **Beldam Asbestos Co. Ltd.,** and of **Auto-Klean Strainers, Ltd.,** has been transferred to 109 Fenchurch Street, London, E.C.3. (Tel: ROYal 1148.)

* * *

Clarkson (Engineers) Ltd., of Nuneaton, announce that, owing to the merger of their agents in Johannesburg, **Wickman Machine Tools (Pty.) Ltd.** and **D. Drury & Co. Ltd.,** they have opened their own Johannesburg branch in South Africa to handle the full range of Clarkson tools.

* * *

The Vaughan Crane Co., Ltd., of West Gorton, Manchester, 12, have formed a joint company with **Burn and Co. Ltd.,** of Howrah, West Bengal, and **Martin Burn, Ltd.,** of Calcutta, India, to manufacture mechanical-handling equipment, including overhead electric and



THIS simple test on an aluminium piston treated with Alumilite **HARD** Anodising demonstrates the exceptional resistance to abrasion achieved by this unique process.

Alumilite **HARD** Anodising opens up new fields for the use of aluminium where previously harder metals only could be used. For moving parts such as bearings, pistons, cams, bobbins, generator brush boxes, sliding door runners, artificial knee-joints, etc., this process has proved entirely satisfactory.

There may be many unsuspected applications where Alumilite **HARD** Anodising can save you machinery and material costs. Send us details of your productions and we will gladly advise you.

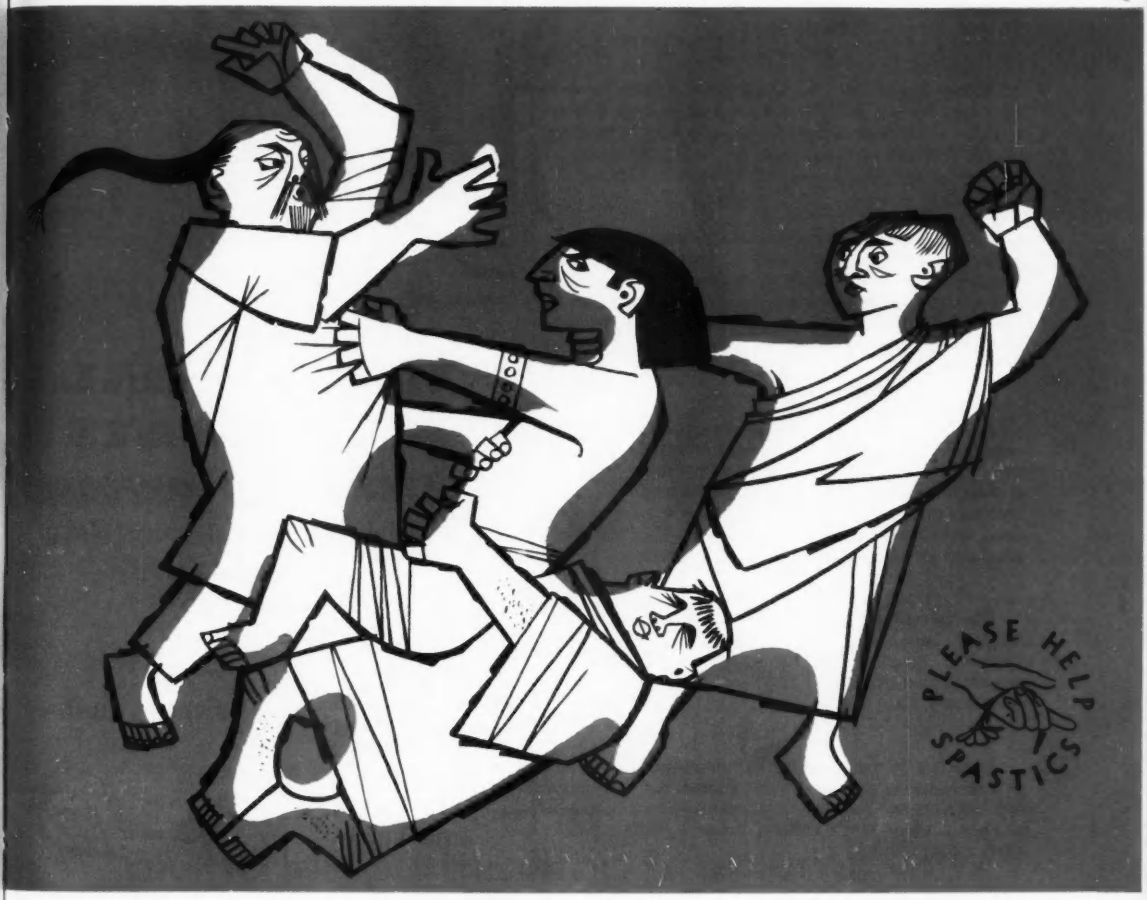
Technical Data Sheets available on request.

ALUMILITE & ALZAK
LIMITED

PRIORY WORKS, DEPT. N, STATION RD., LONDON, S.W.19
Telephone: LIBerty 7641

MIDLANDS: 20/21 MERIDEN STREET, BIRMINGHAM, 5
Telephone: MIDLAND 7426

....almost everyone thought of them first



he Chinese invented everything from writing to rockets.... so they say. They may have pipped e ancient Egyptians; they certainly used them hundreds of years B.C.. The Romans knew about em and used them. As usual, the Greeks had a word for them. Even the Monks of the Middle ges who discovered so many things may well lay claim to the invention of gears. But whoever ought of them first, lots of people make gears now. OPPERMANS OF NEWBURY FOR EXAMPLE. And s in everything else, some people make things better than others. OPPERMANS OF NEWBURY FOR XAMPLE. Oppermans (of Newbury, you will remember) don't claim to have thought of gears first; ut they think of little else now.

OPPERMANS OF NEWBURY

PPERMAN GEARS LTD NEWBURY BERKSHIRE Telephone Newbury 1701 Telegrams Oppigears Newbury

BUSINESS NOTES

hand-operated travelling cranes and hoist blocks. The new company is to be known as **Vaughan Burn Crane Company Private, Ltd.**, of Martin Burn House, 12 Mission Row, Calcutta 1.

* * *

British Ropes Ltd. announce the extension to their wire-rope factory in Mexico, Cables Mexicanos S.A. de C.V., by a new wire mill, which is being built to produce on the spot the necessary wire for rope-making and to meet other specialized wire requirements in Mexico.

* * *

It is announced that **Richardsons, Westgarth and Co., Ltd.** have formed a subsidiary company, **Richardsons, Westgarth Inc.**, with offices in Washington, D.C. The new company will act as a selling agent in the U.S.A. for products made by the company in the U.K. and will also act as a main contractor for plant made in the U.S.A. to Richardsons, Westgarth designs.

* * *

It is announced that **Metal Propellers, Ltd.** have acquired the **Standard Steel Company (1929), Ltd.** Mr. C. Colley, managing director of Metal Propellers, has been appointed managing director of Standard Steel. Mr. D. R. Morgan, who will continue as a director of Standard Steel, has been appointed general manager of the company and also a director of Metal Propellers.

* * *

The **Turret Grinding Wheel Co., Ltd.**, of Sunbury-on-Thames, have been appointed U.K. distributors for Diamond Boart blades for cutting germanium and silicon, manufactured by **Diamond Tool Associates**, of Hawthorne, Cal., U.S.A.

* * *

The main sales engineering and contracts departments of **Lee Guinness Ltd.** have moved from the company's headquarters and factories in Northern Ireland to a newly opened office at 25 Victoria Street, London, S.W.1. (Tel: ABBey 6762.)

* * *

Amber Chemical Industries Ltd., of London, W.1, announce that they have disposed of their controlling interest in **Charles H. Windschuegl Ltd.** to **Mitchell Cotts & Co. Ltd.**, in consequence of their policy of concentrating their resources on the industrial-oil, surface-armouring, and fuel-improver divisions of the group.

* * *

A.H.T. Ltd., of Coventry, announce that they have changed their name to **Haycock Gauge & Tool Co. Ltd.** Mr. H. J. Haycock, until recently managing director of John Harris Tools Ltd., of Warwick, has become managing director of the company.

* * *

Airmec Ltd. announce that they have opened a new showroom at 11 Union House, Union Drive, Sutton Coldfield, Birmingham.

INDUSTRIAL LUBRICANTS

GREASES, GREASE COMPOUNDS

and Molybdenum-Disulphide (MoS_2) Specialities

Make this simple test—

and this

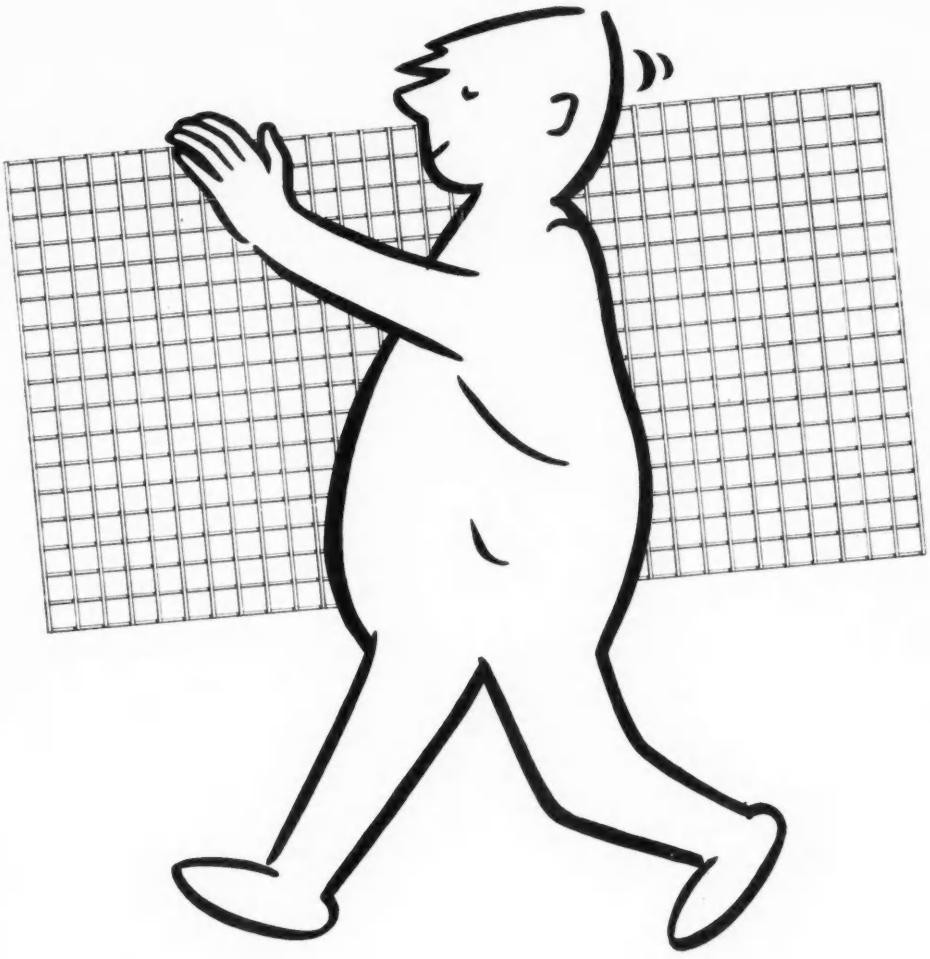
Prove for yourself by placing a small amount in an ordinary refrigerator—or hold over a flame.

Ask for a free sample and mention your lubrication problem.

JET-LUBE LTD.

PARK LANE, FALLINGS PARK, WOLVERHAMPTON

TELEPHONE: WOLVERHAMPTON 31295



here is a man on his way to
solving his partitioning problems with

Weldmesh

Regd. Trade Mark

Cut it to the shape you want—
it holds together because it is welded together

Weldmesh is a registered trade mark and is supplied direct to users by the sole manufacturers:

THE B.R.C. ENGINEERING COMPANY, STAFFORD

London, Birmingham, Bristol, Leeds, Leicester, Liverpool, Manchester, Newcastle, Cardiff, Glasgow, Dublin, Belfast, Bulawayo, Calcutta, Johannesburg, Singapore, Vancouver. Export Sales: 54 Grosvenor Street, London W.1

H-W 963

CONTRACTS

A contract for the construction of the first part of a completely new shipyard at Jacuacanga, near Rio de Janeiro, Brazil, comprising shipyard installations, including a dock and slipway, together with workshops and a jetty, has been awarded to a member company of The Cementation Group of Companies. The Brazilian company, Cementation Brasil S.A.-Engenharia Civil em Geral, of São Paulo, is to sponsor the contract, which is worth more than £1,000,000, on a joint-venture basis with Perini Limited, of Canada. The client concerned in this contract is The Verolme Dock and Shipbuilding Company, of Rotterdam.

* * *

The initial part of a £100,000 contract has been awarded to a British firm, E. G. Irwin and Partners Limited, design, development and consulting engineers, for a materials-handling plant to be built in Northern Spain. The contract is exclusive of the building and civil work necessary. The Spanish steel concern, Ferroaleaciones y Electrometales S.A., of Santander, have placed the contract for the conveyors, bunkers, elevators, and transportation system of a ferromanganese and ferrochrome plant which will be commissioned by the end of 1960. The main contractors are Mecánica de la Pena S.A., of Bilbao.

* * *

An order has been received by The Power-Gas Corporation (Australasia) Pty. Ltd., a member of the Power-Gas Group, from Sulphide Corporation Pty. Ltd., a wholly-owned Australian member of the Consolidated Zinc group, for the supply and erection of a charge-handling plant for a new smelter being erected at Cockle Creek, near Newcastle, N.S.W. The value of the order is about £A.300,000, and the installation is to be completed by the end of 1960. The new smelter, which is an improved vertical-furnace type developed by Consolidated Zinc's main U.K. subsidiary, Imperial Smelting Corporation, will utilize the blast-furnace principle to produce zinc and lead simultaneously.

* * *

Mitchell Engineering Ltd., Mechanical Handling Department, announce that they have been awarded a £2,000,000 contract by Richard Thomas & Baldwins, Ltd., for mechanical handling equipment for the new Spencer Steel Works at Llanwern, near Newport. The order covers ore- and coal-screening, crushing, and conveying machinery and storage plant. Work is due to be finished by March, 1961.

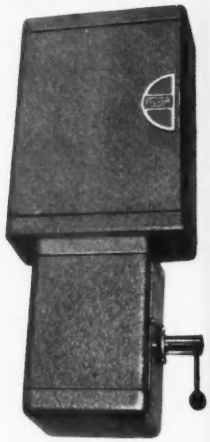
* * *

Amongst contracts recently received by Hayward Tyler & Co., Ltd., a member of Stone-Platt Industries, are those for large-capacity centrifugal cargo oil pumps for three 77,000-ton d.w. tankers to be built by A. G. " Weser " for the Esso Group. Each vessel will be fitted with three cargo pumps, and each pump has a capacity of 2250 tons of sea-water per hour operating against 150 psig and driven by steam turbines rated at 1250 bhp. In

AEROFLEX Fluvent

CABINET STYLE DISTRIBUTION BOARDS

Widespread acceptance of surface mounting Fluvent Cabinet Style Boards has resulted in the production of Switches of similar exterior, intended principally for use as control switches mounted in conjunction with the boards. Both boards and switches have pressed steel cabinets which are cadmium plated and painted to give a grey metallic hammer finish.



The range has been further reinforced by the production of boards for recessed mounting, illustrated left. They are designed to allow the main body of the board to be sunk into a wall cavity of appropriate depth; the plasterwork and wall finish are then made up to the surrounding surface-plate provided.

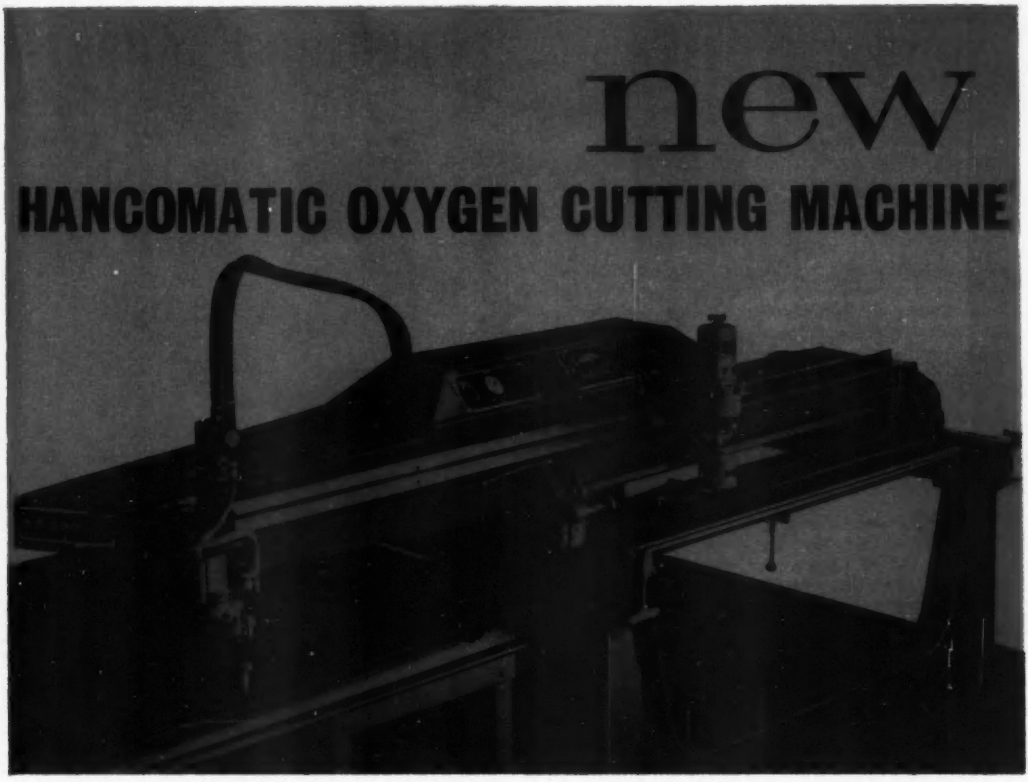
Aeroflex

ENERGY LIMITING FUSES

Fluvent Cabinet Style Distribution Boards are fitted with Aeroflex Energy Limiting High Breaking Capacity Rewireable Cartridge Fuses to BS.88-1952 Cat. 440 AC5 Class P. Standard fully wired cartridge fuse links are included unless otherwise specified, when appropriate underwirings can be fitted.

Parmiter Hope & Sugden Limited
MANCHESTER, 12.
London: 34 VICTORIA STREET, S.W.1.
Glasgow: 5 SOMERSET PLACE, C.3.
Birmingham: 39/41 CARRS LANE, 4.

dm PH130



Now available in 90″ & 120″ cutting widths

Hancomatics ! Today's finest range of dual carriage oxygen profiling machines. In addition to machines with 40″ and 62″ cutting widths, there are now Hancomatics with 90″ and 120″ cutting widths. Hancomatic means top speed, precision cutting—every time; as clean as nearly 40 years specialist experience in cutting can ensure.

NEW sleek enclosure protects moving parts from dirt and dust.
NEW rigid box construction.
NEW electrically operated cutting oxygen valve with instant shut-off.
NEW tracer head for operation from all types of template.

★ The 120″ width machine is *Britain's largest*. A standard machine of this type can be equipped for a cutting area of as much as 500 square feet.
The new Hancomatic embodies the best principles of oxygen cutting in a handsome, enclosed streamlined machine. Take a big step towards streamlining your production. *Write for details:*

. . . and the NEW
Electronic HANCOLINE traces from pencil drawing *automatically*

- ★ Cut width compensation on tracer head.
- ★ No need for templates.
- ★ Equipped with the Hancock patented roller drive—no physical contact between tracer and drawing.
- ★ Supremely simple in operation.

Available with 38″, 60″, 90″ and 120″ cutting widths.
Send for descriptive leaflet.

HANCOCK & CO. (Engineers) LTD.
PROGRESS WAY · CROYDON · SURREY · *Telephone:* CROydon 1908

TIB. 169

CONTRACTS

addition, Hayward Tyler & Co. Ltd. will supply one centrifugal ballast pump with a capacity of 1350 tons of sea-water per hour for each ship.

* * *

A comprehensive contract for all the electrical equipment in three steel rolling mills has been awarded to English Electric by Colvilles Limited for their new Ravenscraig plant, near Motherwell, the biggest industrial project ever undertaken in Scotland. All the equipment will be engineered by English Electric's Metal Industries Division, and mainly manufactured at the company's Stafford works. Manufacturing will also be carried out at Bradford, Liverpool, and Kidsgrove, and delivery will be completed by the end of 1961.

* * *

A special-purpose computer, capable of setting up an electronic analogue of a complete nuclear power station, is to be used by Calder Hall as a trainer for reactor operators. This 200-amplifier instrument is being built by Short Brothers & Harland Limited, who secured the contract in face of strong competition.

* * *

Following the recent statement of The United Steel Companies Ltd. that they are to spend £10,000,000 installing what will be the largest electric steelmaking plant in the world at their Steel, Peech and Tozer branch, G.W.B. Furnaces Limited announce that they are to supply the first two giant electric arc furnaces for this project, each furnace having an electrical rating of 40,000 kVA.

* * *

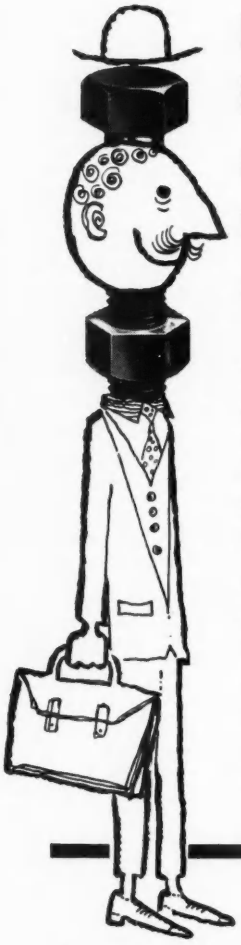
William Boby & Company Limited, water-treatment engineers, of Rickmansworth, Herts., have been awarded contracts valued at £16,000 for dealkalization/base-exchange plants by George Wimpey & Company Limited for the Union Carbide Limited works at Hythe, Hants.

* * *

The first equipment under a £2,750,000 railway-electrification contract awarded through the Polish Government agency, Elektrim, has been despatched by British Insulated Callender's Construction Co. Ltd., one of the three British manufacturers who are parties to the agreement, the other two companies involved being the English Electric Co. Ltd. and Metropolitan-Vickers Electrical Co. Ltd.

* * *

It is announced that the new steelmaking plant to be installed by Consett Iron Company Ltd. as part of their current development plan will be the first plant in the world to use both the L.D. and the Kaldo oxygen steel-making processes. The contractors are Head Wrightson Iron and Steel Works Engineering, a subsidiary of Head Wrightson & Co. Ltd., who are to build two 100-ton L.D. units and two 100-ton Kaldo units. The plant is expected to go into production at the end of 1961.



he's got his head screwed on the right way!

When it's a question of bolts and nuts, the wise man will always choose Richards. In every capacity they have proved their indefatigable tenacity. Richards bolts and nuts, available as both black and bright, will stand up to any normal stress; where stresses are excessive, use the famous "Hi-Strain" brand for the absolute maximum of safety.

for any nutty problem call in

RICHARDS

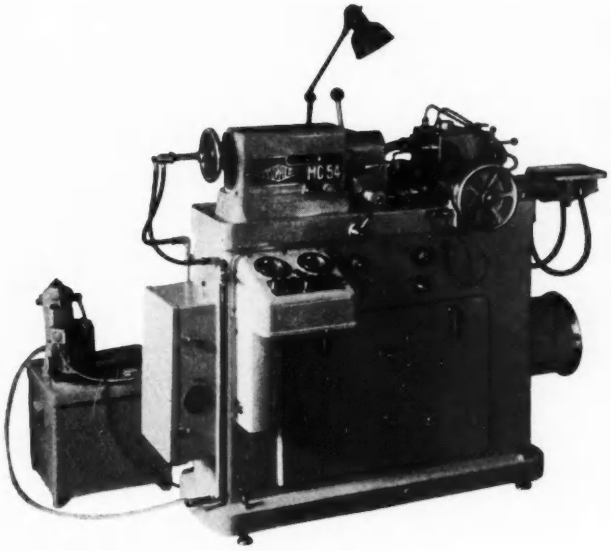
manufacturers of nuts, bolts and fastenings for industry.

CHARLES RICHARDS & SONS LTD.
P.O. BOX No. 23
DARLASTON - WEDNESBURY - SOUTH STAFFS.
'Phone : James Bridge 3188 (8 lines) P.B.X.
Wires : 'Richards' Darlaston.

INTERNAL GRINDER

for production of Injectors
and high-precision components

FRATELLI COPPIER MILANO



TECHNICAL CHARACTERISTICS

Internal grinder for holes of 1 to 20 mm diameter in high-hardness alloys, e.g., gauges, dies, etc. Spindle Speeds from 60,000 to 140,000 rpm. —Quick adjustment for control of diameters, with automatic feed of the spindle head: automatic stop— Supply voltage according to requirements. Weight of complete Grinder approx. 750 kg.

CONSTRUCTIONAL FEATURES

Grinder specially designed for the mass production of injectors of any type, for the internal grinding of gauges and dies in tungsten carbide and other alloys, for work requiring a very high degree of precision of the order of 0·0003 mm both in roundness and centricity with surface micro-roughness of 0·00025 mm. Perfectly smooth surfaces are obtained, in view of the complete absence of harmful vibrations. The perfect finish of the surfaces, combined with exact geometrical shape, is always assured by the M.C.54 Grinder fitted with patented M.C.52 "Turbo Spindles", with automatic take-up of bearing play, oil-mist lubrication, and other features introduced into its construction. All the adjustments of the individual members of the machine are hydraulically controlled. The machine is fitted with turbine-driven spindles of very high rotational speeds, from a minimum of 60,000 to a maximum of 140,000 rpm; one of these spindles serves to grind cylindrical parts and the other to grind conical parts (e.g., injector and valve seats) according to requirements.
The rotating spindle unit of the M.C.52 "Turbo Spindles" employ a small turbine and the hydraulic system adopted, as compared with electrically-driven spindles, affords numerous advantages, including the following :—

- **simplicity of construction.**
- **variable speed range between the limits required, depending upon the internal dimensions to be ground.**
- **normal operating speed : 120,000 — 130,000 rpm**
- **speed variation between full and no load about 3-4%.**
- **extremely simple automatic lubrication, without the need for cooling equipment.**
- **possibility of grinding diameters from 1 to 20 mm.**
- **automatic take-up of bearing play by means of a patented device which guarantees longer life to the bearings.**
- **operating life of the spindle at least 800 working hours guaranteed.**
- **high-precision grinding and finishing of the parts.**

FRATELLI COPPIER-MILANO (ITALY) PIAZZA CARRARA, n.15

'Phone: 84.90.386

PERSONAL

Mr. J. L. Lutyens, M.A., A.M.I.Mech.E., has been appointed group director of research of the Pressed Steel Co. Ltd., of Cowley, Oxford.

* * *

The English Steel Corporation, Ltd. announce that they have appointed **Mr. T. R. Middleton, B.Sc.,** director of research and a director of the company. **Dr. H. H. Burton, C.B.E.,** has retired from the board of directors, but will continue as a research consultant to the group until December 31, 1960.

* * *

The Mobil Oil Co. Ltd. announce that **Mr. C. M. Klaerner** has been appointed a director of the company in place of **Mr. A. L. Lanckton,** who has resigned. **Mr. B. R. Fraser** has been appointed manager of a new manufacturing department, to be located at the head office of the company. His former position of manager of the Coryton refinery has been filled by **Mr. J. W. Bartholomew,** former assistant refinery manager at Coryton.

* * *

Mr. A. J. Marles, B.Sc., A.C.G.I., A.M.I.Mech.E., has been appointed technical manager of the Ransome & Marles Bearing Co. Ltd., of Newark-on-Trent.

* * *

Brigadier H. P. Crosland, C.B., C.B.E., M.C., T.D., D.L., chairman and managing director of Metal Traders Ltd., has been elected chairman of the Zinc Development Association for 1960. **Mr. R. T. de Poix, O.B.E.,** former chairman, will continue as a member of the council of the association.

* * *

It is announced that **Mr. C. N. Freeston, A.M.I.E.E.,** has been appointed group projects engineer for the Frederick Braby group of companies; **Mr. J. F. Nash, A.M.I.E.E.,** has been appointed chief engineer of Auto Diesels Limited.

* * *

Babcock & Wilcox Limited announce that **Mr. A. S. Peacock, A.M.I.Mech.E., M.Inst.F.,** has been appointed purchasing controller in place of **Mr. J. S. Greenhalgh,** who has become manager of the newly-formed construction-equipment division of the company.

* * *

Mr. J. Greatorex has been appointed chief inspector of Sintered Products Limited, of Sutton-in-Ashfield.

* * *

Associated Electrical Industries Ltd. announce that **Mr. D. Edmundson, B.Sc., M.I.E.E.,** has been appointed general manager of A.E.I. (Rugby) Ltd., and that **Mr. H. E. Cox,** who has been general manager at Rugby since 1957, will devote his time to the duties of deputy director of manufacture. It is also announced that **Mr. J. E. A. Heale,** formerly works manager of the Motherwell works of Metropolitan-Vickers (now A.E.I.

THE LONG AND THE SHORT . . . OF IT

IN COARSE PITCH SCREWS

We can
Threadmill
Threadgenerate
Threadwhirl
Threadroll
Threadcut
Threadgrind

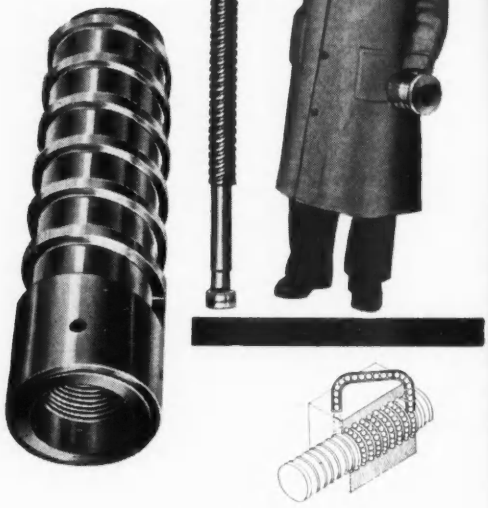
Internal or External Special and Multi-start A.I.D.

Approved C.I.A.

Approved Suppliers to Ministry of Supply and leading manufacturers.

PRECISION MADE SCREWS AND NUTS TO SPECIFICATION

SPECIALISED EQUIPMENT AND WIDE EXPERIENCE ENABLE US TO QUOTE YOU KEEN PRICES



Recirculating Ball nuts and screws

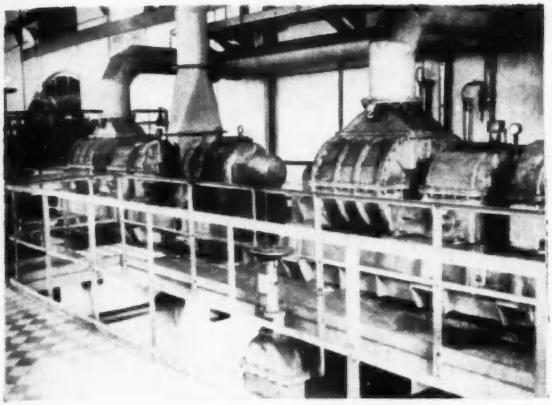
JOHNSON PRECISION INSTRUMENTS

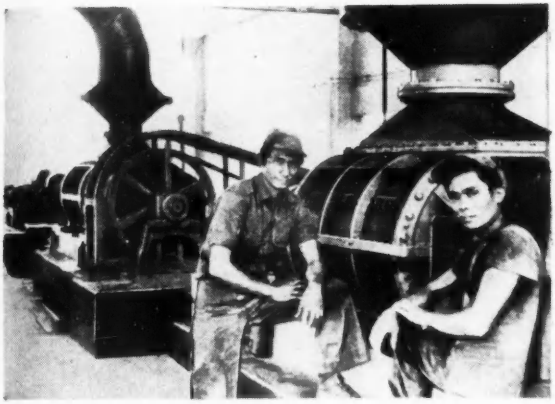
ASSOCIATES OF METALLIFACTURE

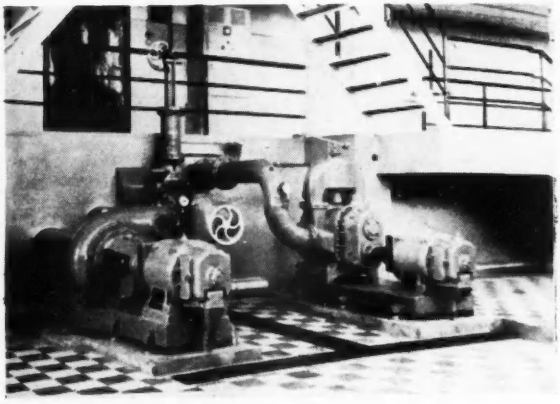
JOHNSON PRECISION INSTRUMENTS (NEWMAN GRANGER) LTD

240-246 HUNTINGDON STREET, NOTTINGHAM

Telephone: 51813







ABOVE: LYONS LA MOUCHE GASWORKS, FRANCE. Two ROOTS-HIBON gas compressors, type HL 320, capacity of each unit 3,500 c.f.m. uncleaned town gas. **CEBU, PHILIPPINE ISLANDS.** Two ROOTS-HIBON gas compressors, capacity of each unit 7,000 c.f.m. of dry, sulphurous gas. **CASABLANCA, MOROCCO.** Three ROOTS-HIBON sets, type P.58, in a water purifying station.

"ROOTS" PUMPS

50 years' experience

—International references

ROOTS-HIBON Compressor-Exhausters are distinguished by their advanced design, simple and robust construction, small power requirement per cu. ft. of gas, high efficiency, minimum wear, maintenance and oil consumption.
ROOTS-HIBON Compressor-Exhausters are manufactured in single and two-stages (twin) types. Maximum pressures and vacua delivered are as follows : single-stage, 14 p.s.i. pressure, 15 3/4" Hg. vacuum ; two-stage, 28 p.s.i. pressure. 28" Hg. vacuum. ROOTS experts are available for consultation on all ROOTS problems

The POMPES HIBON *manufacturing programme also includes :*

- *Vacuum pumps and Liquid-ring Compressors.*
- *Rotary Pumps for fluid and viscous media.*
- *Rotary Vacuum Pumps.*
- *Centrifugal Pumps with horizontal and vertical spindles.*

"HIBON have a solution for every pumping problem."
Please request illustrated litérature.

Pompes HIBON

Établissements G. HIBON - ROUBAIX (FRANCE) : 2, rue des Vosges
Sté Belge des Pompes HIBON - BRUSSELS (BELGIUM) : 123, Av. Eisenhower

PERSONAL

(Manchester) Ltd.), has joined A.E.I. (Woolwich) Ltd., as general manager of works. **Sir Arthur Elton, Bart.,** has been appointed controller of the central information department of A.E.I. Ltd.

* * *

The British Iron and Steel Research Association announce that **Mr. S. S. Carlisle, M.Sc., A.M.I.E.E.,** head of the physics department, has been appointed an assistant director of the association.

* * *

Mr. F. W. Tomlinson, managing director of Pyrotenax Ltd., **Mr. J. M. Willey,** director and general manager of Murex Welding Processes Ltd., and **Mr. P. S. Bryant** have been appointed to the board of Murex Ltd. Mr. Tomlinson has been appointed to the board of Murex Welding Processes Ltd.

* * *

BTR Industries Ltd. announce that **Sir Walter Worboys** has been elected to the board and is appointed a deputy chairman of the company.

* * *

Sir John Wrightson, Bart., has been appointed chairman and managing director of Head Wrightson & Co. Ltd., in succession to **Mr. R. Miles,** who has retired but remains on the board of the parent company.

* * *

Mr. A. Nadin, A.M.B.I.M., A.M.I.W.M., has been appointed general manager of Brayshaw Furnaces Limited and of Brayshaw Tools Limited.

* * *

Mr. A. E. Gregg, Assoc. M.C.T., Assoc. I.E.E., has been appointed a director and general manager of Crompton Parkinson (Chelmsford) Ltd. **Mr. A. V. Sowman, M.I.E.E.,** remains managing director of the company.

* * *

Mr. J. F. Robertson, C.A., financial director and treasurer of the Hawker Siddeley Group Ltd., has been appointed a director of Bristol Siddeley Engines Ltd.

* * *

It is announced that **Mr. G. C. Derbyshire, A.M.I.Mech.E., A.M.I.Prod.E., A.M.I.W.M.,** has been appointed works and technical director of Jacobs Manufacturing Co. Ltd. and of Frank Guylee and Son Ltd.

* * *

Lt.-Col. L. F. R. Fell, M.I.Mech.E., has been appointed a consultant to Rolls-Royce Ltd. to act in an advisory capacity on current and future railway-traction projects.

* * *

Mr. J. A. Goddard, director and secretary of Fry's Diecastings Ltd., has been elected chairman of the Zinc

THE FIRST

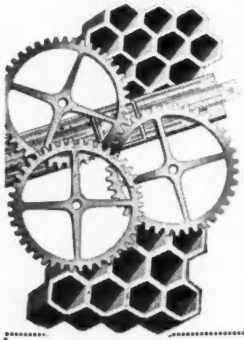
Engineering Materials and Design

EXHIBITION & CONFERENCE

22-26 February 1960

EARLS COURT • LONDON

The Engineering Materials and Design Exhibition will enable engineering designers to examine a wide variety of new components, materials, and design ideas . . . many of which meet the new demands and solve old problems. Concurrently with the Exhibition and in the same building, the journal *Engineering Materials & Design* is sponsoring a Conference at which many leading authorities will speak.



EXHIBITS INCLUDE:

acid resisting materials
alloys
anodes and salts
anti-friction metals
asbestos fabrics
bearings
belting
beryllium
brake linings
castings
ceramics
compressed wood-fibre mouldings
conduits
corrosion resisting materials
fibre glass
hard facing materials
heat resisting materials
hose
insulators
metal coatings
plastics
rubber mouldings
wire

THE CONFERENCE INCLUDES THE FOLLOWING SUBJECTS:

Monday, February 22
Vacuum melted materials
Magnesium alloys Stainless steels

Tuesday, February 23
Beryllium Powder metallurgy
Reinforced plastics Rubber in engineering Plastics for high temperatures

Wednesday, February 24
Developments in fluid power
Centrifugal castings Cast iron as an engineering material

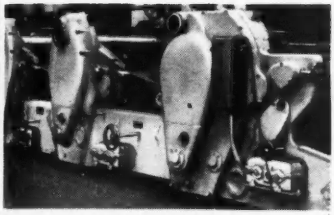
Thursday, February 25
Seals Pumps Safety in design
Engineering design in Britain, Germany and Russia

Friday, February 26
The case for industrial design
Industrial design in engineering
Photo-elasticity in design
High pressure hydraulics

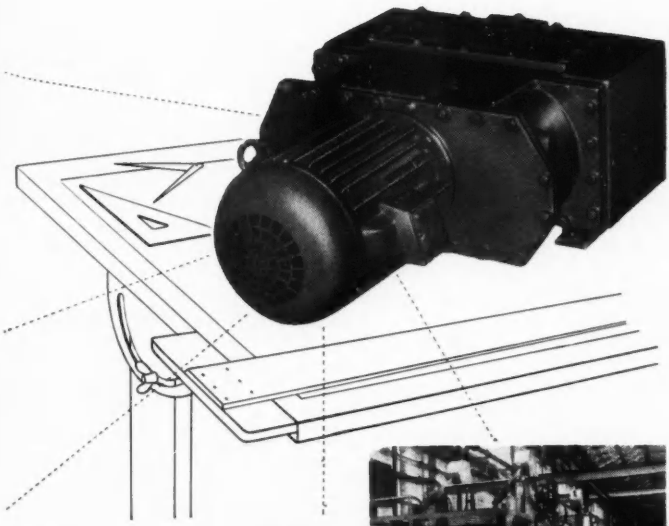
Full details of Exhibition & Conference Lectures from
INDUSTRIAL & TRADE FAIRS LIMITED
Drury House, Russell Street, London WC2
Telephone: TEMple Bar 3422
SPONSORED BY "THE FINANCIAL TIMES" AND "ENGINEERING MATERIALS & DESIGN"

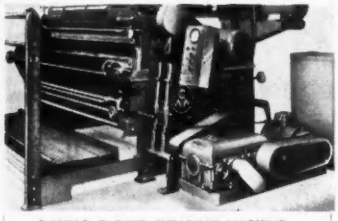
POSITIVE INFINITELY VARIABLE SPEED CONTROL

Wherever precise speed control is a factor of major importance in a manufacturing process, the P.I.V. Drive can be relied upon implicitly. For more than 30 years P.I.V. Gears have been meeting and solving just such problems with an outstandingly high level of accuracy and reliability. In the P.I.V. Gear power is transmitted *positively* through an all-metal chain making tooth-to-tooth contact with metal discs. Slip is virtually impossible and the uniformly high efficiency remains unimpaired throughout years of use.

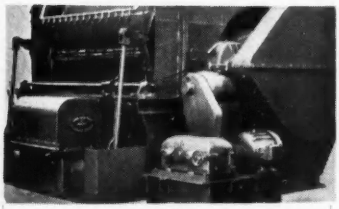


BAKERY OVEN
Courtesy T. & T. Vickers Ltd.

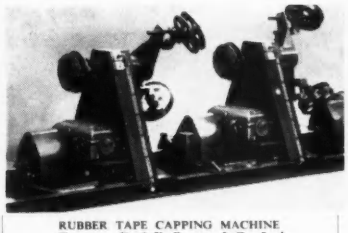




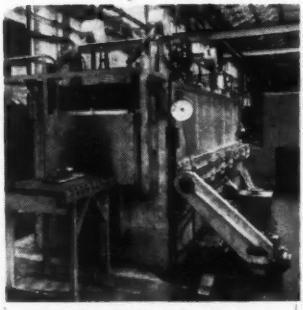
DOUBLE CARPET SHEARING MACHINE
Courtesy William Whitely & Sons Ltd.



FILTER
Courtesy Davey Paxman & Co. Ltd.



RUBBER TAPE CAPPING MACHINE
Courtesy B. & F. Carter & Co. Ltd.



ELECTRICAL FURNACE
Courtesy General Electric Co. Ltd.

Write for literature giving full list of available ratios, power rating tables

STONE-WALLWORK LTD.

32 VICTORIA ST. LONDON S.W.1

Telephone Abbey 7681 Telegrams Stonwalabb London

WORKS: BLEASBY STREET, OLDHAM, LANCASHIRE

The J. Stone Group

Also manufacturers of Worm Reduction Gears, Piece Goods Stamping Machines and Light Alloy Bobbins, for the Textile Trade.

PERSONAL

Alloy Diecasters Association for 1960, in succession to **Mr. K. J. Whitehead,** joint managing director of the Wolverhampton Die Casting Co. Ltd.

* * *

It is announced that **Mr. A. Dormer,** chairman and joint managing director of the Sheffield Twist Drill and Steel Co. Ltd., has been appointed second vice-chairman of the Gauge and Tool Makers' Association, following the death of **Mr. H. G. Carmichael Wilson.**

* * *

Mr. E. A. Robinson, chairman and joint managing director of the Superheater Co., Ltd., has retired from the position of joint managing director, but remains chairman of the company. **Mr. L. C. Southcott,** joint managing director, has become managing director.

* * *

Mr. E. T. Hardy has been elected to the board of Steel Fabricators (Cardiff), a subsidiary of Adamant and Western Engineering.

* * *

Mr. F. A. Wilson has been appointed foundry-machinery adviser at the Bedewell Division of Baker Perkins Ltd., of Peterborough.

* * *

It is announced that **Mr. J. R. Edwards,** works superintendent and a special director of Shepcote Lane Rolling Mills, has been appointed a director of the company. **Mr. F. Brown,** chief engineer, has been appointed a special director.

* * *

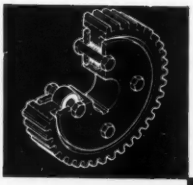
Mr. W. E. A. Williams has been appointed sales manager of Suffolk Iron Foundry (1920) Ltd., of Stowmarket.

* * *

Dr. N. F. Astbury, M.A., Sc.D., M.I.E.E., F.Inst.P., has been appointed director of research of the British Ceramic Research Association, of Penkhull, Stoke-on-Trent.

MR. P. R. COURSEY

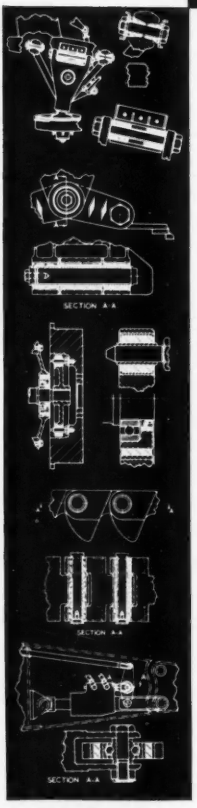
It is with deep regret that we announce the death of Mr. Philip Ray Coursey, B.Sc.(Eng.), M.I.E.E., F.Inst.P., F. Physical Society, M.R.I., on January 3, 1960. From 1920 to 1923, Mr. Coursey, who was the author of several technical books, and the originator and inventor or many important developments, was assistant editor of "Radio Review", and research editor of the "Wireless World" until 1925. He became chief engineer of the Dubilier Condenser Co. Ltd. in 1923, and in 1931 was appointed technical director of the company, retaining this position until his retirement in 1957, when he was appointed technical consultant, in addition to retaining his directorship.



MORE AND MORE
DAY BY DAY

CLAYFLEX

HARRISFLEX



FLEXIBLE BEARINGS SERVE INDUSTRY

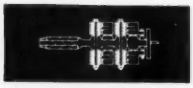
The ever increasing popularity of Clayflex and Harrisflex bearings can only be traced to the confidence engineers, the world over, place in these well proved products.

The pressure and chemically bonded Clayflex bearings are supplied in forms to suit standard and specialized applications. Outstanding in this range is the B.P. type bearing which has been specifically designed to give positive axial control under high radial loadings, and to cater for high conical deflections.

Harrisflex controlled flexible bearings are being used for an ever increasing range of applications, where space and weight restrictions are involved. In addition these units offer advantages in their ease of assembly on production lines.

For further information concerning these products, please ask for the appropriate technical literature. The long experience of our Technical Staff is at your disposal to give advice and submit drawings for your particular application.

HOWARD CLAYTON-WRIGHT LTD.

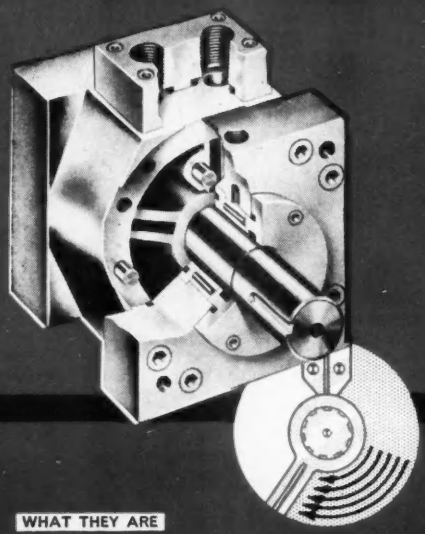


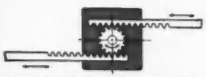
WELLESBOURNE WARWICKSHIRE
Telephone: WELLESBOURNE 316
Telegrams: 'CLATONRITE' WELLESBOURNE

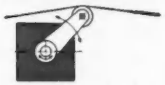
KEELAVITE
Hydraulics

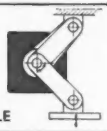
ROTARY TORQUE ACTUATORS
(ROTAC)

give highest torque in least space



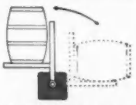

STRAIGHT LINE MOTION—DOUBLE TRAVEL


TROLLEY OR CONSTANT TENSION

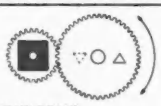

TOGGLE

HIGH TORQUE RATCHET DRIVE

DUMPING OR TUMBLING


ROLL OVER OR UPENDING

TURN OR OSCILLATE


INDEXING

WHAT THEY ARE

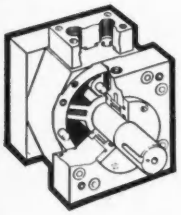
Keelavite/Rotac units are operated hydraulically at low to medium pressures, developing instant torque in either direction. For single vane units the motion is limited to a maximum arc of 280 degrees by the fixed shoe within the cylinder. Power can be doubled by the use of two vanes. In this case the arc of travel is 100 degrees.

WHY THEY ARE BETTER

Torque actuators provide high power in a small space with simple mountings. They can replace other types of actuators, such as cylinders, which require complicated linkage to perform the same functions. In hydraulic systems torque actuators are an ideal solution to many complex mechanical problems.

TYPICAL USES

Opening and closing valves.
Opening and closing doors.
Automation and machine tool uses including:
indexing, feeding, transferring, clamping, locating, turning over.
Freight car tippling.
Crane boom operation.
Pipe and tube bending.
Fatigue test applications.
Foundry equipment.
Materials handling and control of movement on conveyors.



1. *Choice of mountings for fixing at any angle in any position.*
2. *Effective sealing means no oil leak therefore positive control of shaft rotation.*
3. *Working mechanism fully sealed from dirt.*

Keelavite/Rotac rotary actuators are manufactured in the United Kingdom under licence from the XLO *Corporation*

THE RECOGNISED AUTHORITY

For full details write to

KEELAVITE
Hydraulics

KEELAVITE HYDRAULICS LTD
ALLESLEY, COVENTRY. TEL: MERIDEN 441

NEWS ROUND-UP

Annual Conference of the Ergonomics Research Society

The Ergonomics Research Society is holding its Annual Conference at the University of Cambridge from March 28 to 31, 1960. The programme will include two sessions on " Ergonomics in the Armed Forces ", a session on " Ergonomics in the Netherlands ", and a Symposium on " Factors in Prolonged Work, especially Inspection ". The Symposium, which is a new feature in these conferences, will include six papers, an exhibition of experimental apparatus, various visits to Colleges and University Departments, and meetings on topics of sectional interest.

Full particulars regarding the programme, accommodation, etc., can be obtained from the Conference Secretary, Dr. S. Griew, University of Bristol, Department of Psychology, 22 Berkeley Square, Bristol 8. (Tel.: Bristol 24161, Ext. 231.)

Firth Brown Forge Development Scheme

The forge development scheme started by Firth Brown in 1953 with the purchase and installation of a 1750-ton press, with all the necessary furnaces, including a 15-ton rail-type manipulator, is now functioning very satisfactorily. Following the completion of the 1750-ton scheme, a new shop has been built for the installation of a new 800-ton press, equipped with a 3-ton mobile manipulator, and with furnaces of the most modern design, the press being fitted with automatic precision control. This new addition to the forging capacity already shows a tremendous improvement over the old type of equipment.

The next stage in this development scheme is the installation of a new 4000-ton press, this being made possible by the acquisition of the premises of W. Griffiths & Sons Limited in Brightside Lane, Sheffield. The extra space obtained in this way means that the new press, due for operation by early 1961, can be installed whilst the old press is still working. The furnaces in this shop were of the old hand-fired type, and conversion of these to the most modern type of producer-gas furnaces will be completed by the time the press is ready for operation. The extra space acquired, amounting in all to about 50,000 sq ft, will permit extension of the 1000-ton press bay, where three new presses of the 800-ton type are also planned.

Monks and Crane Machine-Tool Exhibition

Staged in the contemporary surroundings of their new 5000-sq ft showroom, the " Machine-Tool Fortnight " Exhibition held by Monks and Crane Limited, of Garretts Green, Sheldon, Birmingham, between January 18 and 29, 1960, made it possible for visitors to see, in pleasant and comfortable surroundings, the wide extent of the Monks and Crane range of machine tools.

Some eighty machine tools were on display, operational and otherwise. Many of these machines are of Continental design, and some of them were on show for the first time in England, among them being the Italian Azeta horizontal boring and milling machine, Model GL80, which is capable of working to extremely fine

still ?

. . . are you still losing time and money by repairing screw threads in the old-fashioned way?
Heli-Coil Screw Thread Repair Kits enable you to replace weak or stripped threads in minutes, at a cost almost too small to estimate!
Simply drill, tap and install a Heli-Coil Insert to produce a conventional thread many times stronger than an unprotected thread. It will outlast the rest of the part!
Although the cost of Heli-Coil Inserts is negligible, they are capable of making items serviceable when the metal is too worn to withstand ordinary screw thread repair. Years of use can now be obtained from parts that would otherwise have to be scrapped. The cost of complete replacements is saved and the inconvenience of delays. Three standard types of Heli-Coil Repair Kits are available, plus Special Purpose Kits " tailored " for particular products. Heli-Coil Inserts are made with either English, American or Metric Threads.

HELI-COIL*
screw thread repair kits

* HELI-COIL is a registered trade mark

MAIL THIS COUPON FOR FULL INFORMATION ABOUT HELI-COIL

PLEASE FORWARD ILLUSTRATED LITERATURE ON HELI-COIL SCREW THREAD REPAIR KITS TO:

NAME .....

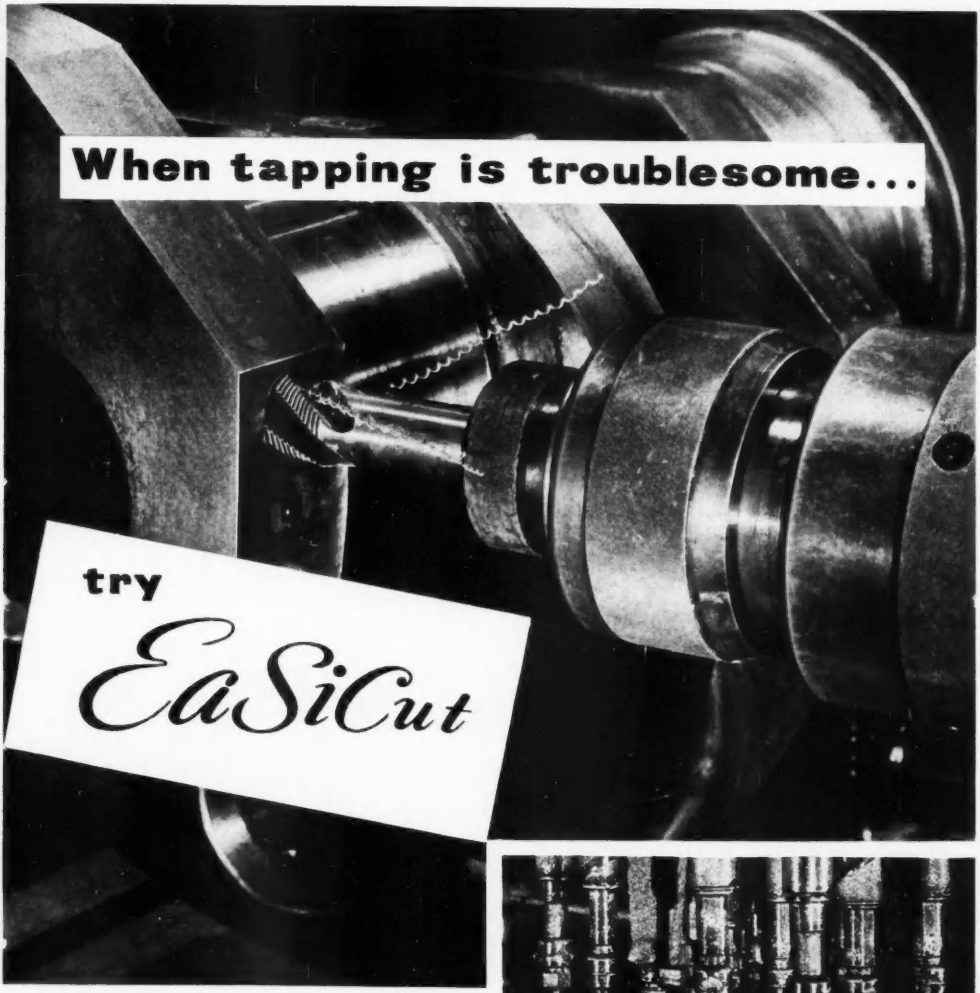
COMPANY .....

ADDRESS.....

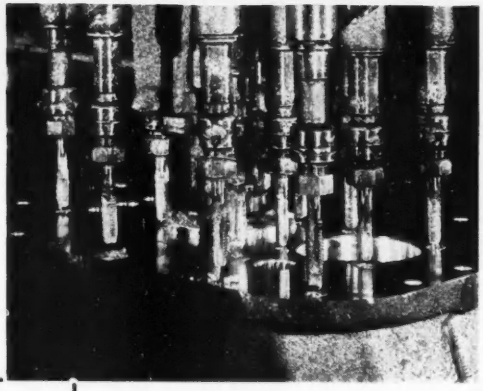
.....

ARMSTRONG PATENTS COMPANY LIMITED,
Eastgate Beverley, Yorkshire. Tel. Beverley 82212 (6 lines)

APL 48/K.9



On manganese crankshafts or magnesium transmission cases, used singly or in multi set ups, EASICUT excel.
When correct size threads in the shortest production times are the requirements, EASICUT taps usually provide the answer.



ENGLISH STEEL
TOOL CORPORATION LTD
North Street Works · Openshaw · Manchester

Makers of high quality Engineers Cutting Tools for over a century

A WHOLLY OWNED SUBSIDIARY OF ENGLISH STEEL CORPORATION LTD., SHEFFIELD

NEWS ROUND-UP

tolerances on experimental and tool-room work. This machine incorporates a number of interesting safety features, and its wide range of speeds and feeds makes it suitable for both general-purpose and production work.

Most of the items exhibited were capable of operation by quick-coupling to an overhead " busbar " power source, enabling visitors to see the practical capabilities of a wide variety of equipment, including the " Victoria V.2. Rapidmill ", the " Zocca " twin-head surface-grinding machine, and the new " Startrite Sabre " band-sawing and filing machine.

First International Pipe and Pipelines Exhibition

Stemming from the remarkable recent technical progress and growing interest in pipes, pipelines, and their ancillary equipment, the First International Pipes & Pipelines Exhibition will be held at Earl's Court, London, between May 30 and June 2, 1960, and will feature the products of about 100 British, European, and American firms.

Covering all types of pipes, hoses, rigid and flexible tubes, pipeline equipment, fabricated pipework, pumps, valves, fittings, chemical plumbing, insulation, protection, testing, and all necessary ancillary equipment and processes for the pipe and pipeline industry, the exhibition, which is sponsored by *Pipes & Pipelines*, enables all ramifications of the industry to be brought together under one roof, so that visitors can see for themselves what is at present available and can examine at leisure the latest developments in materials, techniques, and applications.

Special Plessey Production Unit for Resistors

Following the recently announced agreement between The Plessey Co. Ltd., of Ilford, Essex, and Elettronica Metal Lux S.p.A., for the manufacture of " Metallux" resistors in the U.K., Plessey have set up a special production unit at their Swindon factory for these resistors. Under this agreement, Plessey hold, in addition to the sole manufacturing rights, the selling rights for the U.K. and all Commonwealth countries.

Metallux resistors are constructed of a special nickel-chrome alloy deposited on a ceramic former or core by a vacuum-deposition process which results in a robust and durable film of resistive alloy permanently bonded to the core. The stability, noise, temperature-coefficient, and voltage-coefficient characteristics of the completed resistor are distinctly better than those of conventional fixed resistors. The values of individual resistors are determined by precise spiral or axial cuts made in the resistive film, a range of values from 0·1 ohm to 2 megohms being available, with different temperature and voltage coefficients. Typical applications of these resistors are as power resistors for high wattage dissipation, for large loads at high frequencies, and as low inductance resistors in H.F. attenuators and U.H.F. filters. They are also one of the basic components in the compact epoxy-resin-sealed type " M " attenuators now being made by Plessey for use in computer and telecommunications circuits.

Instruments, Electronics, and Automation Exhibition

With a net stand floor-space of 15,000 sq ft, the third international Instruments, Electronics, and Automation Exhibition, to be held at Olympia, London, from May 23 to 28, 1960, will be twice the size of its predecessors in conception, floor-space, and number of exhibitors. The exhibition, which will be under the patronage of H.R.H. the Duke of Edinburgh, will feature the products of nearly 500 firms, of which about 100 are from overseas, including the U.S.A., France, Belgium, Denmark, Holland, Switzerland, Italy, Austria, West Germany, Czechoslovakia, Poland, and East Germany.

The group of industries sponsoring the exhibition is represented by the British Electrical and Allied Manufacturers Association, the British Industrial Measuring, and Control Apparatus Manufacturers' Association, the British Lampblown Scientific Glassware Manufacturers' Association, the Drawing Office Material Manufacturers' and Dealers' Association, the Electronic Engineering Association, and the Scientific Instrument Manufacturers' Association of Great Britain. It is not surprising, therefore, that the range of exhibits will be an extremely wide one, and will include such items as data-processing equipment, control and production-line equipment, simple and complex laboratory equipment, medical equipment, and high-temperature and low-temperature equipment.

In addition, the Electronic Forum for Industry (EFFI), founded two years ago as a means of projecting to all users and potential users of electronic equipment the wide scope of the electronics industry, will be staging

" RUBERT " High Precision Feeler Gauges

can be supplied

AS LOOSE BLADES IN PLASTIC CONTAINERS
IN BOXES OF ASSORTED BLADES to simplify storekeeping

Ideally suitable in the workshop, Inspection Room, etc. as Packings, Shim Steel, etc. From 0.0008" to 0.030"

Ask for leaflets

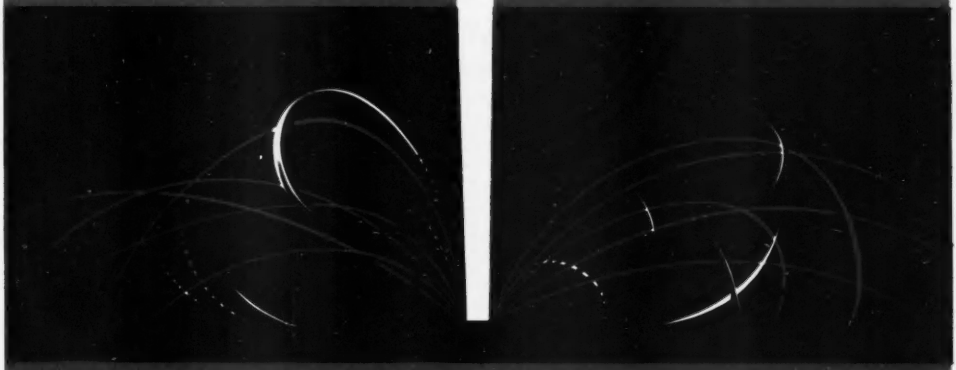
We also make any thickness and size of Feeler Gauges to customers requirements

RUBERT & CO. LTD. **ACRU WORKS, DEMMINGS ROAD, CUNCILLOR LANE, CHEADLE, CHESHIRE** **Telephone: GATley 5855**

THERE'S AN

AEI Electrode

FOR EVERY WELDING JOB



For downhand welding of mild steel

the SPEEDIVICK

The ideal contact iron powder electrode.

- For long fillets, intermittent welding and butts to high radiographic standards
- Produces finely finished work quickly and easily
- Rapid burn-off rates permit high current without overheating
- Slag easily detachable or self-releasing
- Approvals include Lloyds, and the Ministry of Transport.

For full technical details write for descriptive leaflet 767/6-1

The AEI range of 'Giant Builder' Electrodes includes

EH · SYLVICK · MINIVICK · UNIVICK · VERTIVICK · TENSIVICK
NICHROVICK · PYROVICK · CASTIVICK · P250 · MOLVICK · LOCREEP

Associated Electrical Industries Limited

TRANSFORMER DIVISION — HEATING & WELDING DEPARTMENT

Trafford Park - - - Manchester 17

L/P804

For accuracy, ease of reading, robustness, economy and long, trouble ree life install Rototherm Thermometers, Controllers and Recorders. Specialists in bi-metallic applications. **Write for details.**

Rototherm

BI-METAL MERCURY-IN-STEEL VAPOUR PRESSURE
THE BRITISH ROTOTHERM CO. LTD.
Merton Abbey, London, S.W.19 **LIBerty 7661 (6 lines)**
Midland Factory: Hollis Street, New Basford **Nottingham 77847**

a three-day symposium, to be held in the Olympia Conference Hall from May 25 to 27. Further particulars can be obtained from the Exhibition organizers, Industrial Exhibitions Ltd., 9 Argyll Street, London, W.1. (Tel: GERrard 1622.)

The 12th Liège International Fair

To avoid clashing with other European fairs in April and May, the 12th Liège International Fair, Belgium, will be held this year between June 2 and 16, but will remain a purely technical exhibition, with its principal sections devoted to mining equipment, metals, and mechanical and electrical engineering, presented in 22 industrial groups. Standing in its own grounds on the banks of the river Meuse, the fair covers a total area of about 10 acres, made up of two exhibition halls covering 7 acres and an open-air section of 3 acres.

In addition, four important international conferences will be held in Liège in the first half of June, 1960, and will deal with welding, building, spectroscopy, and greater hygiene and safety at work. As in the past, the themes of these four conferences will be illustrated by staging within the framework of the fair four special exhibitions devoted to machinery and equipment essential to these subjects.

Further details regarding this fair can be obtained from the U.K. representative, Mr. R. C. Liebman, 178 Fleet Street, London, E.C.4 (Tel: CITy 5889).

Symposium on Rocket and Satellite Instrumentation

The Society of Instrument Technology and the British Interplanetary Society will hold a one-day Symposium on rocket and satellite instrumentation in London on September 1, 1960, with the object of indicating the fields of new scientific knowledge which have been opened up by experiments in the upper regions of the atmosphere and in outer space, and of describing the kind of instrumentation which has either already been used or which will be required for future research.

Eight papers will be presented, including an outline of the investigations planned for the British space programme; a design study on a communication satellite; a digital data reduction system for use in the static testing of rocket motors; transducers for rocket-motor testing; the measurement, transmission, and recording of data in the "Skylark"; and ultra-violet measurements from satellites.

Classified Advertisements

The rate for all classified advertisements is 9d. per word : in bold print 1s. per word : minimum order 10s. Box-number advertisements 1s. extra. Semi-displayed advertisements on this page 60s. per single column inch. Instructions, together with remittance, must be received not later than the 1st of each month for advertisements to appear in the same month's issue.

WILMOT BREEDEN FELLOWSHIP

Applications are invited for a Fellowship to be held in association with the College of Advanced Technology, Birmingham. The value of the Fellowship, which is for a two-year term, is £1,000 per annum. A candidate for the Fellowship should normally have had two or three years research or industrial experience. He should have an honours degree or equivalent qualification and be acceptable to the College of Advanced Technology as a research fellow.

The Wilmot Breeden Fellow would engage in an enterprise of such a character as to require the facilities both of the College and the Company, his time being spent at both. His enterprise may have the character of Scientific Research, Design, Development, a combination of some or all of these, or in some other way to be appropriate to the activities of Wilmot Breeden. The Company is especially concerned with Mechanisms, Electro-Chemistry, Metal Finishing, Metallurgy, Metal Formation, Hydraulics, Electronics.

Full details may be obtained on application to—Mr. F. Sargeant, Secretary, Wilmot Breeden Fellowship Committee, Amington Road, Birmingham, 25.

Final applications must be received by the Secretary before 1st May 1960.

OSMOND

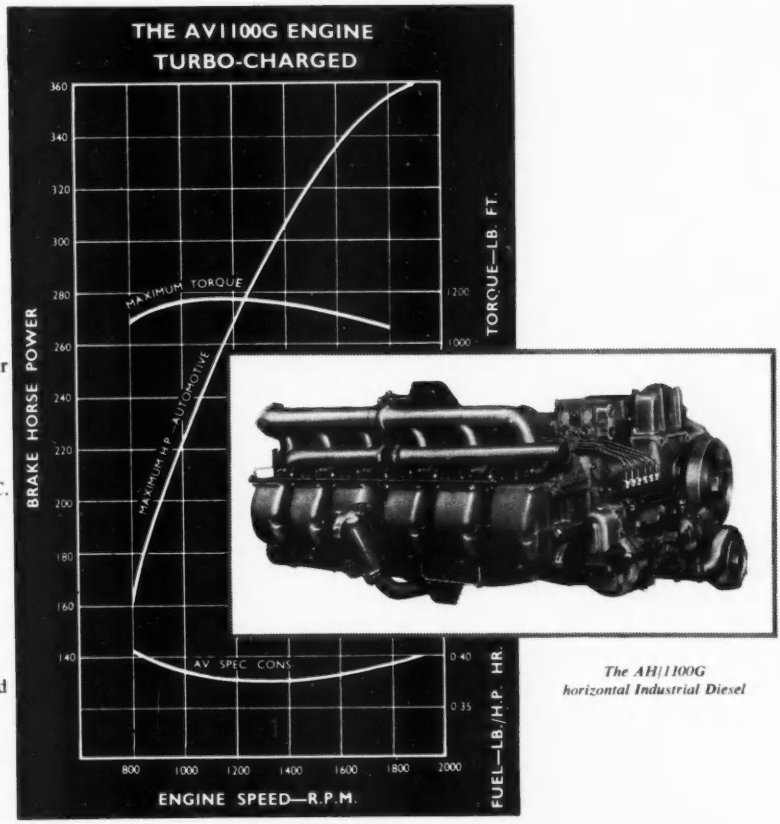
CUTTING OFF MACHINES

A. & S. OSMOND, LTD. Telephone:
13 DOWRY SQ., BRISTOL. Bristol 27604

Where you need

POWER

You need A.E.C. *diesels*



When you need power, whether for intermittent or long continuous running, power which is always instantly available, power at low cost, then the answer must be A.E.C. For mobile or stationary use, A.E.C. offer a range of high-torque industrial engines ranging from 50 b.h.p. to 275 b.h.p. Turbo-charged — a standard alternative — they go up to 360 b.h.p.
Every A.E.C. diesel has behind it the experience of nearly 30 years in diesel design and production, and a world-wide service and spares organisation that never sleeps.

The AH/1100G horizontal Industrial Diesel

A.E.C. LIMITED · MARINE AND INDUSTRIAL DIVISION
SOUTHALL · MIDDLESEX

MI/509

NEW TECHNICAL BOOKS

Energy Principles in Applied Statics. By T. M. Charlton, M.A., B.Sc.(Eng.), A.M.I.Mech.E. 120 pp., 58 illustrations. Publishers: Blackie & Son Limited, 17 Stanhope Street, Glasgow, C.4. Price: 25/–.

As the author points out in his preface to this interesting and well-written book, there appears to be some confusion among engineers and students regarding the nature and uses of the several energy principles of applied statics. This confusion is probably due mainly to the description of Castigliano's well-known use of strain energy in the analysis of linear statically indeterminate structures as the " principle of least work "—an unfortunate misnomer, as the book clearly demonstrates. Furthermore, the approach to the analysis of structures embodied in Castigliano's method is only one of two possible approaches, and it is probably another source of misunderstanding of principles that the alternative approach is seldom considered explicitly. This approach is embodied in the method of potential energy and leads to the true principle of least work, which is applicable to conservative statical methods in general and is not bound up with linearity.

The object of this book is therefore to remove some of the confusion existing with regard to the uses of the various energy principles of applied statics. As a result, the two basic approaches to the analysis of statical systems are considered explicitly and, in addition to clarifying energy principles, an appreciation of the duality aspect in analysis is obtained by readers.

Regression Analysis. By E. J. Williams, D.Sc. 222 pp., 5 illustrations. Publishers: John Wiley & Sons, Inc., New York, and Chapman & Hall Limited, 37 Essex Street, London, W.C.2. Price: 60/–.

Emphasizing the practical problems of interpretation and exploring situations in which a technique is relevant and appropriate, the author of this interesting book on one branch of statistics approaches the subject of regression analysis from both the theoretical and applied viewpoints. Clear discussions are provided on the distinction between regression and functional relationships, showing when each is required and how each may be determined. Throughout the book, the methods are amply illustrated by examples taken from practical experience in the fields of agriculture, biology, chemistry, and forestry.

Statistics of Extremes. By E. J. Gumbel. 396 pp., 97 illustrations. Publishers: Columbia University Press, New York, and Oxford University Press, Amen House, Warwick Square, London, E.C.4. Price: 120/–.

Undoubtedly one of the most useful guidebooks and texts in existence in its particular field, this statistical study of extreme values is an original contribution to the calculus of probabilities and, in addition to the author's own work, calls attention to many fundamental studies by scientists working in different fields in many countries. Fundamentally directed towards statisticians and statistically minded engineers, geophysicists, and climatologists, the book has a wide range of application in science, industry, and technology. Thus, for instance, the theories and equations presented can be used for finding preventive measures against floods and droughts, for calculating the risks involved in the construction of dams, bridges, reservoirs, hydro-electric plant, etc. and making life tables for these structures, and for calculating the endurance of metals.

Professor Gumbel, who is Adjunct Professor of Industrial Engineering at Columbia University, writes well and lucidly. As a result, by keeping his subject as far as possible to an elementary level, he has been able to extend considerably the usefulness of this book, which is a pioneer work, the first of its kind to be devoted entirely to the statistics of extremes. Graphical procedures are used to replace complicated formulae and, to stimulate further research in this rapidly growing field, numerous problems and exercises are also included.

Production Tooling Equipment. Second Edition, 1960. By S. A. J. Parsons B.Sc., M.I.Mech.E., M.I.Prod.E., M.B.I.M. 340 pp., 244 illustrations. Publishers: Cleaver-Hume Press Ltd., 31 Wright's Lane, Kensington, London, W.8. Price: 28/–.

Providing ample material for students of Tool Design as a subject for examination, either for the Higher National Certificate in Production Engineering or for the Associate Membership examination of the Institution of Production Engineers, this reference book has enjoyed justifiable popularity since the appearance of the first edition in 1954. This new edition has been revised and expanded, and now includes new material on ceramic tools and workshop and inspection gauges, on throw-away tool tips, and on automation, together with a number of other revisions and improvements.

The design of drilling jigs and fixtures is well covered and, as far as possible, each jig and fixture is discussed relative to the component with which it is to be used, in conjunction with simple and clear diagrams. In the section on cutting tools and tool layouts for various production machines, special attention has been devoted to the design and application of cutting tools—a subject often neglected or inadequately presented—and a number of features, not generally found in similar books, are given, including a section on micro-drilling, the design of high-rake milling cutters, broach design, and a comprehensive tooling layout for a sliding-head type of automatic. The design of practical gauges, such as those commonly used for production, is also discussed, and a selection of typical examination questions is included.

CHAPMAN & HALL

★ *NEW BOOKS* ★

SMALL GAS TURBINES
AND FREE PISTON ENGINES
by
ARTHUR W. JUDGE
Illustrated — 48s. net

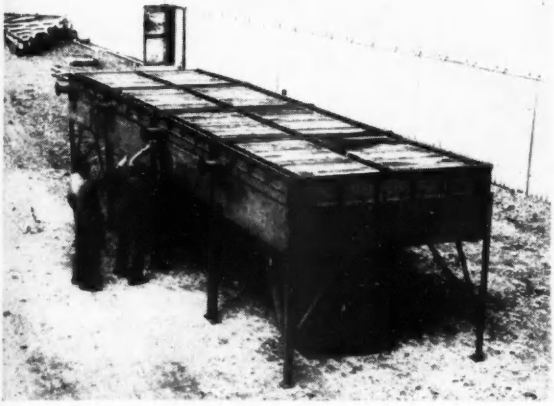
Nature and Properties of ENGINEERING MATERIALS
by
Z. D. JASTRZEBSKI
A JOHN WILEY BOOK
Illustrated — 88s. net

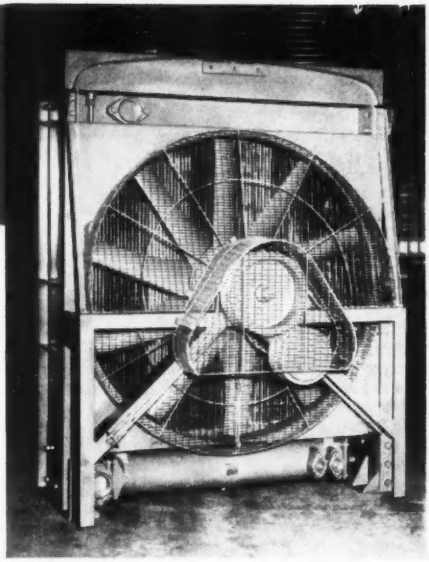
EXPLODING WIRES
Edited by
W. G. CHACE & H. K. MOORE
A unique book based on a Conference on the Exploding Wire Phenomenon.
A PLENUM PRESS BOOK
Illustrated — 76s. net

37 ESSEX STREET, LONDON, W.C.2

SERCK

HEAT EXCHANGE EQUIPMENT



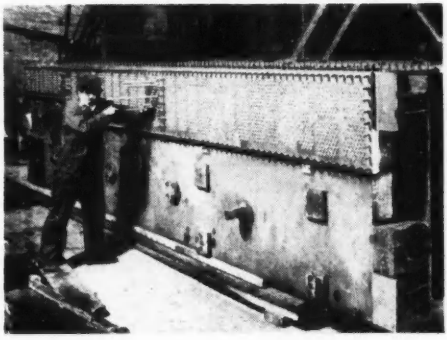


SERCK Combined Radiator and lubricating oil cooler for oil well drilling sets.

SERCK Horizontal type SECTIONAL RADIATOR.

and QUALITY TECHNICAL TUBES for THE OIL INDUSTRY

SERCKALBRA (Aluminium Brass)
SERCKCUNIK (Copper Nickel)
ADMIRALTY BRASS
ALUMINIUM BRONZE
70/30 BRASS



Evaporator for refinery by Procon (Great Britain) Ltd. being tubed with SERCKALBRA Photo by courtesy of Richardson, Westgarth & Co. Ltd.

SERCK RADIATORS LIMITED · SERCK TUBES LIMITED
Warwick Road Birmingham 11 England
MEMBERS OF THE SERCK GROUP

ST/2P

LATEST INDUSTRIAL LITERATURE

1. Filtration Equipment and Oil-Conditioning Plant. An illustrated 14-page brochure describes a range of filtration equipment, including special plate and frame pressure filters for general duties and enclosed filter presses for dust- or moisture-free filtration or for filtering volatile fluids. A conditioning unit is also dealt with, which separates solid dispersants from fluids and facilitates the treatment of oils by dehydration. Details are also given of complete oil-filtration plants suitable for the purification of steam-turbine lubricating oils, for sump-oil recovery, for conditioning transformer oils, etc.

2. Electrochemical Etching. Aluminium, brass, steel, monel, and a number of other metals can be instantaneously marked by a new electrochemical etching process described in a 4-page leaflet. The deposited marks become an integral and permanent part of the metal surface without causing any stress or strain distortion, deformation, or displacement of the metal. A further advantage of the process is that it can be carried out by unskilled personnel and, not only requires low currents, but also uses harmless salt solutions as electrolytes which do not give off harmful vapours and cannot damage clothing.

3. Deposit Welding Process. An illustrated 24-page brochure describes a deposit welding process, whereby with high-speed cutting tools a greater cutting efficiency can be obtained with the deposit than with the original parent metal. Deposits made by this process have controlled carbon and controlled composition, which mean that the weld can be annealed, machined, hardened, re-ground, etc., exactly in the same way as the parent metal. Examples of tools to which the process is being applied are included, as well as extracts from reports of users of various applications of the process.

4. Roof-Ventilator Units. High aerodynamic efficiency, good resistance to corrosion, and modern styling are some of the main advantages of the glass-fibre-reinforced plastic roof-ventilator units described in a 4-page leaflet. Salient features of these units, which are manufactured in four basic sizes delivering from 2000 to 9000 cu ft of air per minute, include a fully reversible impeller, a hinged cowl which readily exposes the motor for servicing, and a cable duct which protects electrical work.

5. Slideway Grinding Machine. An illustrated 20-page brochure describes in detail a slideway grinding machine adapted to the latest advances in grinding technique. The weight of the machine is 70 tons approximately. The work table, 10 m long and 1600 mm wide, is composed of two parts and rests on a box-type bed. The tableway, consisting of amply dimensioned flat and V-ways, is covered with plastic sheets which improve sliding characteristics and reduce wear. Particular attention has been paid to the lubrication of the tableway, ensuring an oil film of as constant a thickness as possible between bed and table.

MAIL THIS COUPON TO-DAY

THE ENGINEERS' DIGEST, 2.60
120 Wigmore Street, London, W.1.

Date.....

Please send free and without obligation the literature indicated by the following circled numbers:

1 2 3 4 5 6 7 8 9 10 11 12 13

Name .....

Position .....

Company.....

Address .....

6. Zinc-Alloy Rustproofing. Written with the object of explaining the history, operation, and application of a special zinc-alloy rustproofing process, a 62-page handbook serves as a useful reference manual for engineers, designers, metallurgists, and others concerned with problems of surface protection and rust prevention. Chapters are devoted to the technology and various practical applications of the process, and test results are included which clearly demonstrate the high degree of protection afforded.

7. Dry-Fluid Centrifugal Couplings. Recommended for marine applications and for various uses in the wire, paper, and textile industries, a dry-fluid centrifugal coupling is presented in an 8-page brochure. These couplings can perform the functions of an automatic clutch, of a torque-limiting device, as well as of a torsional-vibration absorber. Furthermore, as their slippage on full load is negligible, there are no power losses which can have an adverse effect on fuel consumption.

8. Fire-Protection Equipment. The range of fire-protection equipment described in an illustrated 12-page brochure includes chemical and mechanical foam engines and dry-powder, vaporizing liquid, soda-acid or water, and carbon-dioxide fire extinguishers. Complete fire-extinguishing installations, as well as fire-detecting systems, are also dealt with.

9. Hydraulic Presses. Eminently suitable for bushing, bending, and straightening of sheet and plate, a range of hydraulic frame presses is presented in a 2-page leaflet. Two additional leaflets deal with arch presses designed for the heavy working of medium to small components and with open-gap presses recommended for straightening, hot- and cold-forming, and general press-work. The presses are robustly built and simple in construction, and are claimed to give trouble-free operation with a minimum of maintenance.

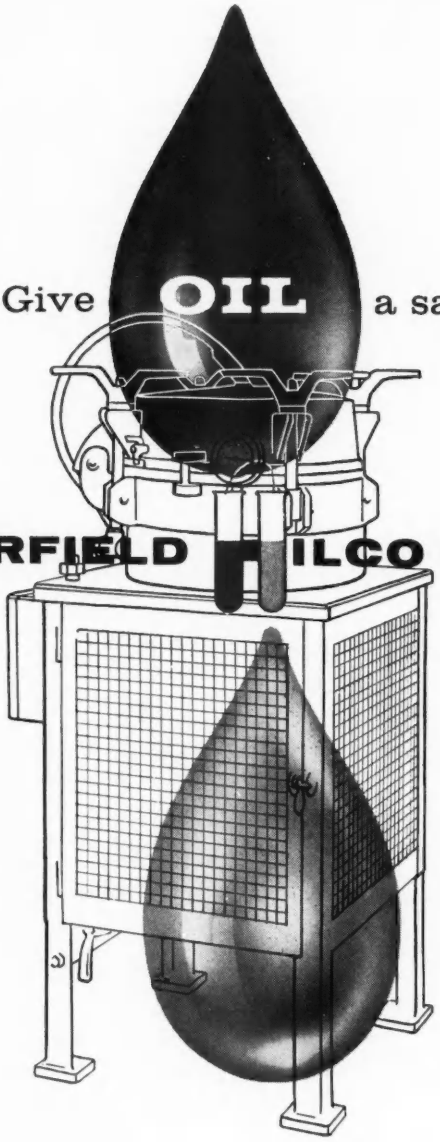
10. Fluorescent-Lighting Equipment. An illustrated 8-page brochure contains particulars of a range of fluorescent-lighting equipment, such as corrosion-proof reflectors for laboratories and plating shops, weather-proof reflectors for external use, as well as fluorescent trough reflectors and ceiling channels. Details are also given of a special trunking with detachable reflectors, which permit of installing a flexible lighting installation wherein changes can be made by unplugging the fitting and sliding it to a new position without disturbing the mains wiring.

11. Welding Machines. The range of fully-automatic flash butt-welding machines described in an illustrated 8-page brochure covers a number of basic types with manual, hydraulic, or pneumatic tooling. A supplementary 8-page brochure gives particulars of rocker-arm spot-welding machines, manufactured in pedal-operated and pneumatic versions, with or without automatic timing control. Numerous optional extras, such as automatic scale-compensation devices, ignitron contactors and electronic forge time controls, are also available.

12. Jointings and Packings. Descriptions are presented in an illustrated 128-page catalogue of a range of jointings and packings, suitable for the majority of industrial and marine applications. Introductory notes on the selection of the correct jointing material for a particular application are given, as well as information on storage, thickness and fitting. A section is also included on jointing and packing recommendations for marine and industrial engineers, as well as a packing reference table.

13. S.G. Iron Properties and Applications. Describing in detail the properties of S.G. iron and listing a number of important applications, an illustrated 26-page brochure includes a section on design considerations for this material and a section giving numerous tables and information on strength, toughness, ductility, elasticity, fatigue resistance, hardness, wear resistance, thermal properties, and corrosion resistance. Among the applications featured are examples of the use of this material in power, transport, and mining and chemical plant.

Give OIL a safe passage through



BIRFIELD HILCO OIL RECLAIMERS

Birfield Hilco Oil Reclaimers are new to this country. In effect they are miniature oil refineries which remove contaminants as quickly as they are formed. Consequently oil changes are kept to an absolute minimum. Birfield Hilco Oil Reclaimers are available for single or multiple engine installations of any horsepower. They are self-contained, compact, easy and quick to service.

SUITABLE FOR TRANSFORMERS, VACUUM PUMPS, AND STEAM TURBINES.

Manufactured by

INTERMIT LIMITED

MEMBER OF THE BIRFIELD GROUP

BRADFORD STREET · BIRMINGHAM 5 · ENGLAND · PHONE: MIDLAND 7961

ALLEN – STOECKICHT EPICYCLIC GEARING

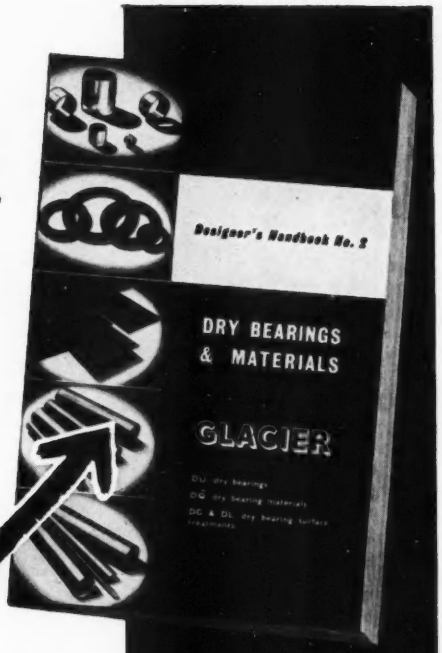
for INDUSTRIAL and MARINE applications

Please address all enquiries for gearing to
W. H. ALLEN SONS & CO. LTD.,
ATLAS WORKS, PERSHORE,
Worcestershire.

The most compact speed-reducing or speed-increasing arrangement for all types of prime movers and/or driven machinery

W. H. ALLEN SONS & Co LTD BEDFORD

Designers!
Is this
on your
shelf yet?



The designer who has known and used GLACIER DRY BEARINGS for years — and pointed out how right he was — can now save not only cost and maintenance in mechanical assemblies, (to say nothing of oil), but his own time and trouble too!

Glacier Designer's Handbook No. 2 is out now!

This new handbook makes the drawing of most dry bearings quite unnecessary: all you need do is quote the Part number. In addition it provides COMPLETE TECHNICAL DATA on properties, dimensions and tolerances for DU and DQ Dry Bearings and Materials — as well as on DG and DL process treatments.

THIS BOOK SHOULD BE IN THE HANDS OF EVERY DRAUGHTSMAN!

FREE OFFER:
We will send to any company, on receipt of a request from an official of the company, a copy of the Glacier DESIGNER'S HANDBOOK No. 2 for each of their draughtsmen.

We will also send a copy to any individual draughtsman who writes to us on his company's letterheading.

Write now to:

GLACIER

THE GLACIER METAL COMPANY LTD
DEPT. 4
ALPERTON · WEMBLEY
MIDDLESEX

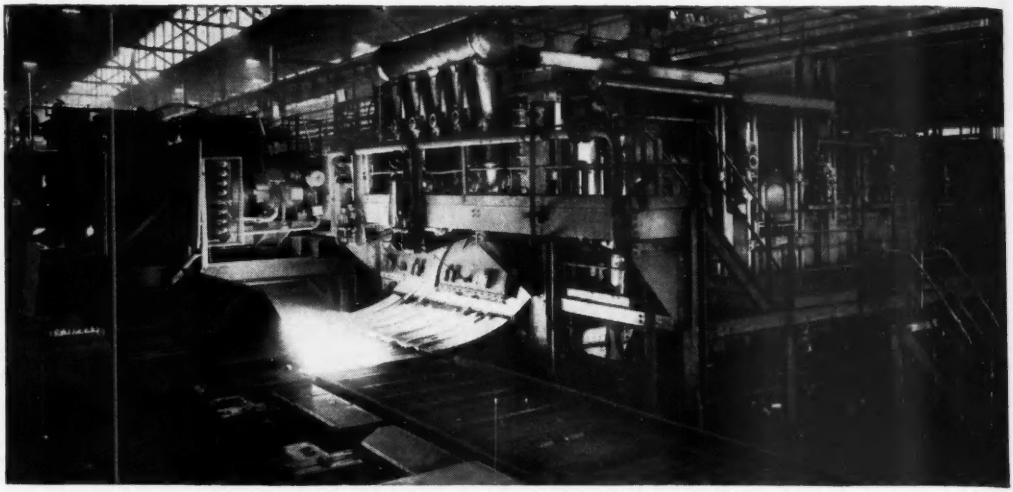


Fig. 1. A hot slab being ejected from the furnace on to the roller table.

THE GLAMOUR OF STAINLESS STEEL

Stainless Steel—a British discovery by Brearley in Sheffield in 1913, overcame the atavistic tendency of ordinary steels to return to iron oxide as rust.

Now highly polished Stainless Steel adds glamour to kitchens and hotel, office and shop fittings. Perhaps more important, its resistance to corrosion offers a hygienic surface to the food manufacturing industries, large scale caterers and for hospital equipment, including sterilisers and the surgeon's delicate instruments.

This glamour applies not only to Stainless Steel products, some of which are illustrated in this article, but also to its processing. In fact, the ultimate durability of Stainless Steel depends upon a precise temperature/time heating and reheating schedule, which processes are usually carried out by town gas because of its inherent flexibility as a heating medium.

Fig. 1 shows a close-up view of a slab heating furnace at Shepcote Lane Rolling Mills Limited—a subsidiary company of Firth-Vickers Stainless Steels Limited, in which Samuel Fox & Co. Limited have a one-third interest. In the illustration a red hot slab has just been ejected on to the run-out table. This furnace heats nine tons of slab hourly at a temperature of 1,230°C before ejection, using 35,000 cubic feet of town gas per hour—each slab weighing approximately three tons. The impressive machinery used to process Stainless Steel is shown in Fig. 2—the plant producing either matt or mirror-finished coiled strip. In the background are shown the gas-fired slab-heating furnace and the primary rolling section. The gas-fired coil reheating furnaces and the automatically controlled four-high finishing mill together with the run-out table are shown in the foreground.

Fig. 2. A general view of the hot mill bay showing furnaces, Steckel Mill and run-out table.

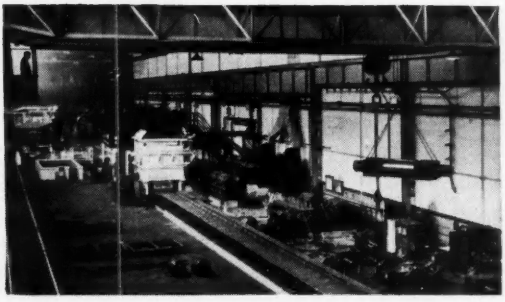


Fig. 3. The four-high hot Steckel Mill installed at Shepcote Lane Rolling Mills Limited.

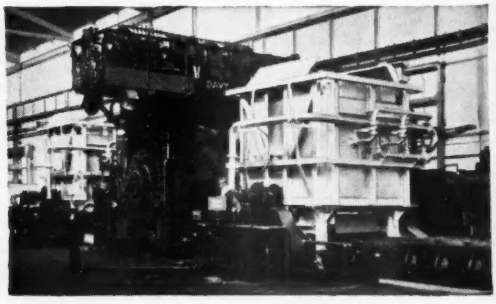


Fig. 3 shows the complex four-high Steckel Mill with its adjacent coil reheating furnaces. Each furnace is rated at 8,000 cubic feet per hour, and the plant will roll up to nine passes with a drop in temperature of the steel of only 250°C.

The treatment of Stainless Steel is only one of thousands of different trades, professions and processes served by the Gas Industry. Each Area Gas Board has specialist staff familiar with the heating problems of these many industries. They all pool their ever-increasing knowledge through the Gas Council's Industrial Gas Development Committee, whilst the Industrial Gas Information Bureau keeps in touch with developments in gas-fired equipment in all parts of the world. Thus any user, or potential user, of gas-fired equipment has a fund of technical knowledge available to him by asking for the services of his Area Gas Board.

Fig. 4. A sterilising unit for surgical and dental instruments.

Scottish Gas Board, Edinburgh
Northern Gas Board, Newcastle-on-Tyne
North Western Gas Board, Manchester
North Eastern Gas Board, Leeds
East Midlands Gas Board, Leicester
West Midlands Gas Board, Birmingham
Wales Gas Board, Cardiff
Eastern Gas Board, Watford
North Thames Gas Board, W.8
South Eastern Gas Board, Croydon
Southern Gas Board, Southampton
South Western Gas Board, Bath

The Gas Council, 1 Grosvenor Place, London, S.W.1

Fig. 5. Receiving and storage tanks for margarine blends in the processing department of Van Den Berghs & Jurgens Ltd., Stork Margarine Works, Purfleet.

Fig. 6. The Wimpy, Lyon's Corner House, Coventry Street, London.

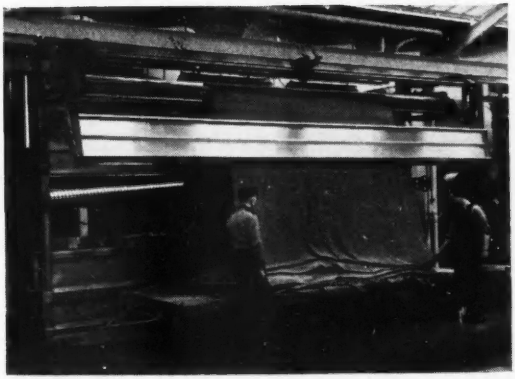
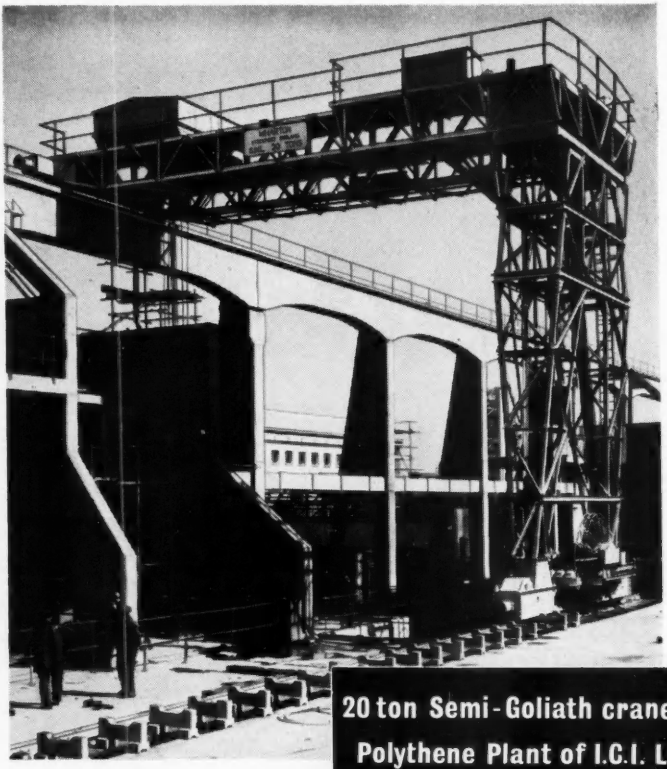
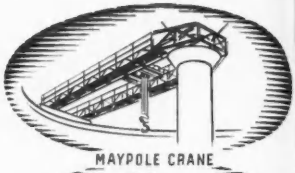


Fig. 7. The largest stainless steel carpet dyeing machine ever produced in Great Britain.

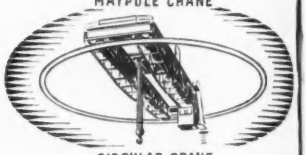
Cranes for Special Applications



20 ton Semi-Goliath crane at Polythene Plant of I.C.I. Ltd

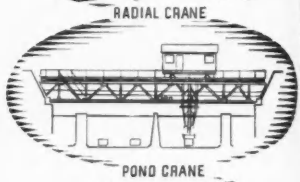


MAYPOLE CRANE

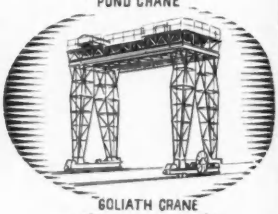


CIRCULAR CRANE

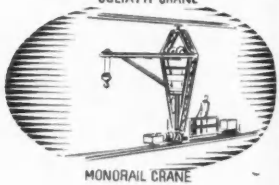
RADIAL CRANE



POND CRANE



GOLIATH CRANE



MONORAIL CRANE

The crane making industry is today being charged with the design and production of cranes for special application and Wharton Crane & Hoist Co. Ltd. have an international reputation for the many specialized fields they serve.

The Wharton technical advisory service is available for individual consideration of your problem.

THE WHARTON CRANE & HOIST CO. LTD.

REDDISH STOCKPORT ENGLAND

Phone: Heaton Moor 2227. Grams: "Gallant, Manchester." Code: Western Union.

LONDON: Lincoln House, 296-302 High Holborn W.C.1.	Phone: Chancery 7911.	Grams: Chancery 7911.
SCOTLAND and NORTHERN COUNTIES: Gordon Baxter & Co. Ltd., 25 Blythswood Square, Glasgow C.2.	Phone: Central 6917/8	Grams: Gorbaxco, Glasgow.
MIDLANDS: A. R. Holland & Son, 89 Cornwall Street, Birmingham 3.	Phone: Central 1457	Grams: Central 1457, Birmingham.
SOUTH-WEST: R. C. Collins, 48 Westbourne Road, Penarth, Glamorgan.	Phone: Penarth 58527.	Grams: Penarth 58527.
NORTHERN IRELAND: General Engineering Products Ltd., 7/9 Great Patrick Street, Belfast.	Phone: Belfast 23743.	Grams: Belfast 23743.
REPUBLIC of IRELAND: Charles Nolan & Co., 2 Parker Hill, Lower Rathmines Road, Dublin	Phone: Dublin 93510.	Grams: Dublin 93510.
CANADA: Marshall Equipment Co. Inc., P.O. Box 28, 61 O'Connell Avenue, Dorval Station P.Q.	Phone: Melrose 1-3528.	Grams: Marequipco, Montreal.
Gordon Russell Ltd., 1661 West Fifth Avenue, Vancouver 9, B.C.		Grams: Rustle.
Mumford, Medland Ltd., 576 Wall Street, Winnipeg, Manitoba.	Phone: 37-180, 37-187-188-189.	Grams: Mandem.
SOUTH AFRICA: Kenneth Ray Ltd., P.O. Box 5662, 34 Ameshoff Street, Braamfontein Johannesburg	Phone 44-2168.	Grams: Gamray.

REPRESENTED IN PRINCIPAL COUNTRIES THROUGHOUT THE WORLD

Before there's cause for alarm

get clear warning

and protection

with

AEI alarm and warning equipment

- Crane approach warning devices
- Photo-electric alarms and warning systems
- Factory control communication equipment
- 'Single-phasing' protective relays for three-phase motors
- Conveyor safe-starting systems

Please write for further information and technical data. If you have a special problem our engineers will be glad to assist you.

AEI

Associated Electrical Industries Limited

Electronic Apparatus Division

NEWPARKS, LEICESTER, ENGLAND

A 5383

KENDALL & GENT

Broaching Machines

Photograph by courtesy of
The Butler Machine Tool Co. Ltd.
Halifax

This photograph of the No. 2 Broaching Machine illustrates its pleasing lines and simple design. All movements of the draw-head are controlled by a single lever at the operating position.

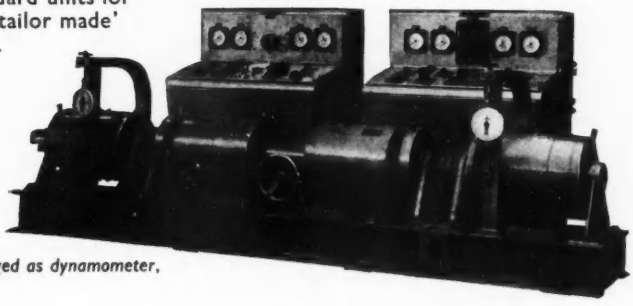
Write for illustrated catalogue giving details of No. 2 and 3 size machines.
No. 2—44 in. stroke, 15 ton pull
No. 3—60 in. stroke, 20 ton pull

KENDALL & GENT LTD
GORTON MANCHESTER
Phone EAST 1035

K248A

POWER AND CONTROL

E.D.C.C. machines and control gear are available to meet most requirements. Standard units for straightforward applications and 'tailor made' specials for the most diverse uses.



Recently supplied to the Welsh College of Advanced Technology, Cardiff — a multiple motor generator set, comprising 4 machines and two control desks. The machine unit comprises:—

- *7h.p. D.C. variable speed motor, arranged as dynamometer, complete with Tacho-generator*
- *4kVA alternator*
- *4kVA alternator with rotatable stator*
- *7h.p. synchronous motor (left to right) arranged as dynamometer*
- *The complete unit can be split into two motor-alternator sets*

ELECTRO-DYNAMIC

CONSTRUCTION COMPANY LIMITED

ST MARY CRAY KENT PHONE: ORPINGTON 27551 GRAMS: ELEDAMIC ST MARY CRAY

CONTROL GEAR DIVISION: BRIDGWATER SOMERSET TEL BRIDGWATER 2882 GLASGOW OFFICE. 40 HOULDSWORTH ST C3 TEL: CENTRAL 2620

DESIGNERS! THIS IS THE ONE REFERENCE BOOK TO SOLVE YOUR FLUID SEALING PROBLEMS — AND IT'S FREE!

When you design Fluid Seal applications, don't be without this valuable Reference Book issued by Pioneer. Prepared by practical engineers, it includes the latest up-to-date information on Fluid Seal Technology, comprehensive data on a wide variety of applications, how to install correctly with easy-to-follow illustrations for all the various types of seals produced by Pioneer, and a full range of available sizes. The Pioneer Reference Book which comes to you on request, is a practical work for the busy designer and is part of the Pioneer service which includes free advice on any Fluid Sealing problem.

Pioneer

OILSEALING & MOULDING CO. LTD

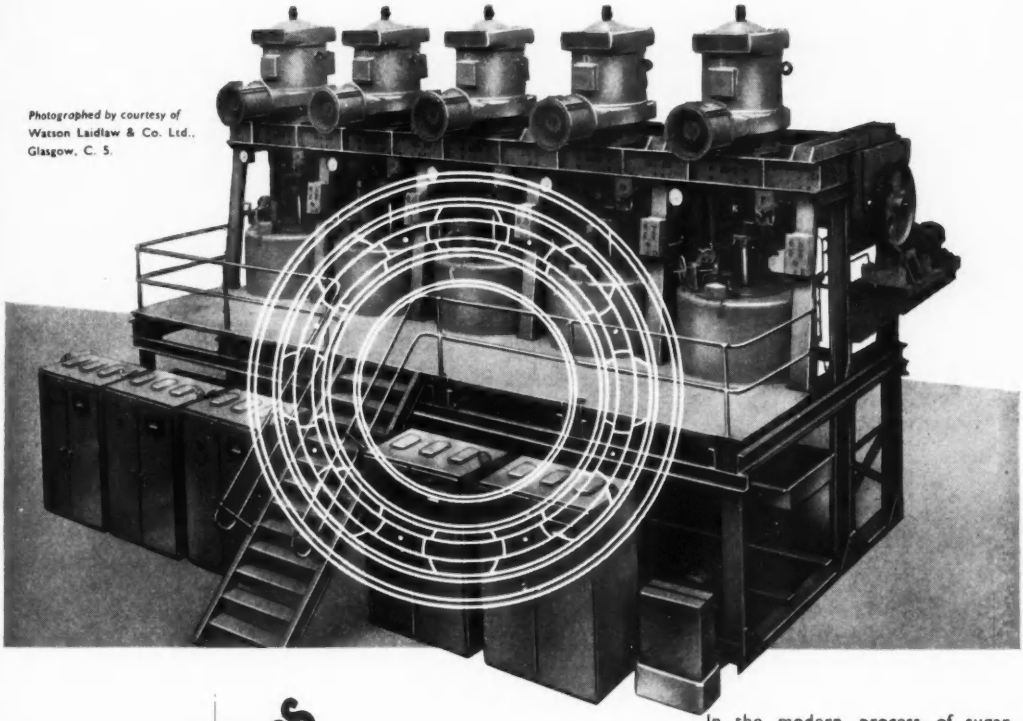
Factory and Head Office : Cottontree Works, Colne, Lancs. Tel: Wycoller 471 (8 lines)

GET YOUR COPY OF THE PIONEER FLUID SEAL CATALOGUE *NOW*

COMPANY NAME

ADDRESS

MARK FOR THE ATTENTION OF

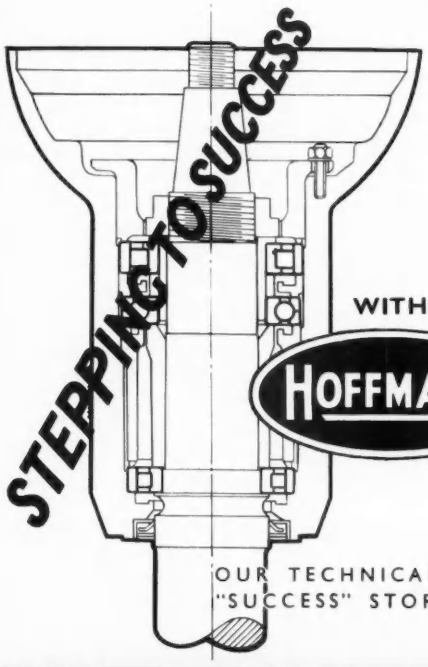


Photographed by courtesy of Watson Laidlaw & Co. Ltd., Glasgow, C. 5.

In the modern process of sugar manufacture the high-speed centrifugal machines must work throughout the crop night and day without interruption. Obviously the bearings must be man enough for the job (HoffMANN of course): hence the assembly of the bearing head, showing two parallel roller bearings and one duplex ball bearing. These together, take care of the combined heavy journal and thrust loads.

The mounting is well sealed at the lower end to prevent completely any risk of grease contamination.

The illustration shows five 48" x 24" electrically-driven centrifugal machines capable of curing 1050 cubic feet of massecuite per hour.



STEPPING TO SUCCESS

WITH

HOFFMANN

BALL AND ROLLER BEARINGS

OUR TECHNICAL PEOPLE ARE BEHIND MANY "SUCCESS" STORIES IN BEARING APPLICATION

THE HOFFMANN MANUFACTURING CO. LTD., CHELMSFORD, ESSEX

CROWN WHEEL FORGINGS

for the Rear Axle of the

ALL-NEW FORD ANGLIA

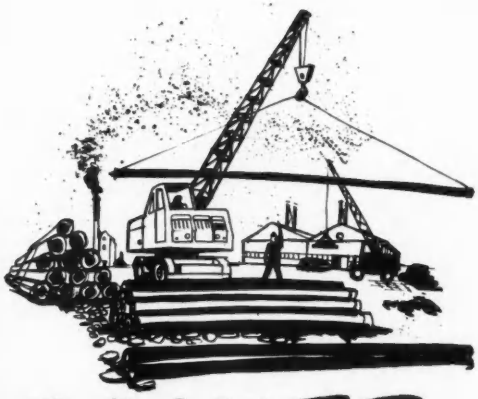
are supplied by

FIRTH-DERIHON

SHEFFIELD & DARLEY DALE

High Quality Drop Forgings for the Automobile and Aircraft Industries

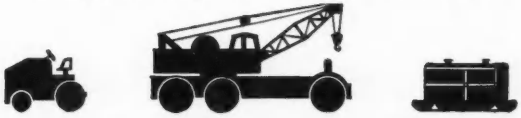
THE FIRTH-DERIHON STAMPINGS LIMITED · SHEFFIELD



POWER for industry

Our range of industrial engines are a practical proposition for many types of industrial equipment **... compressors, cranes, pumps, contracting equipment, earth borers, generators, railcars, welding plant, works trucks, tractors and conversions.** Simple design, modern flow-line production methods and common interchangeable parts contribute to the low cost of these high efficiency engines. And remember, every engine is fully backed by a World-wide Parts and Service Organisation. Take your choice from a wide power range . . . Diesel 20 to 86 b.h.p. and Petrol 11 to 87 b.h.p. (12-hr. rating).

DIESEL ECONOMY—have you considered the replacement of existing power units in your equipment and trucks with the famous 4D Diesel engine? You'll have the unique advantages of economy, long-life and low running costs . . . plus the best service in the World!



Wherever you are, whatever your problem,

FORD

MOTOR COMPANY LIMITED · ENGLAND

are at your service

For further details of our

INDUSTRIAL ENGINES

and the equipment they power, send the coupon to your nearest Ford Dealer or direct to

Please send me technical brochures of your *PETROL/DIESEL Industrial Engines. The maximum B.H.P. required is.....at.....R.P.M. Also, please send details of the following equipment powered by your engines.

.....

.....

Name .....

Address .....

.....

Nature of Business .....

..... **Telephone No.** .....

** Delete where not applicable*

G51·24·2

FORD MOTOR COMPANY LTD · PARTS DIVISION (G51) · AVELEY DEPOT · SOUTH OCKENDON · ROMFORD · ESSEX · ENGLAND

WELDED
PRESSURE VESSELS

in STAINLESS STEEL, MONEL, TITANIUM, HEAVY ALUMINIUM AND MILD STEEL

THE SIGN OF GOOD WELDING

Stainless steel sphere, 2′ 8″ diameter, welded to Lloyds Class 1 in $\frac{7}{8}$″ plate.

We offer a production potential second to none for the fabrication of welded pressure vessels of any size or intricacy of design. We utilise the most advanced welding and inspection control methods and our experience is one hundred years young.

Welded fabrication and fusion-welded pressure vessels to the requirements of Lloyds Class 1, A.S.M.E., A.O.T.C. codes and similar specifications.

JENKINS *of Rotherham*

ROBERT JENKINS & CO. LIMITED, ROTHERHAM

Telephone 4201-6 (6 lines)

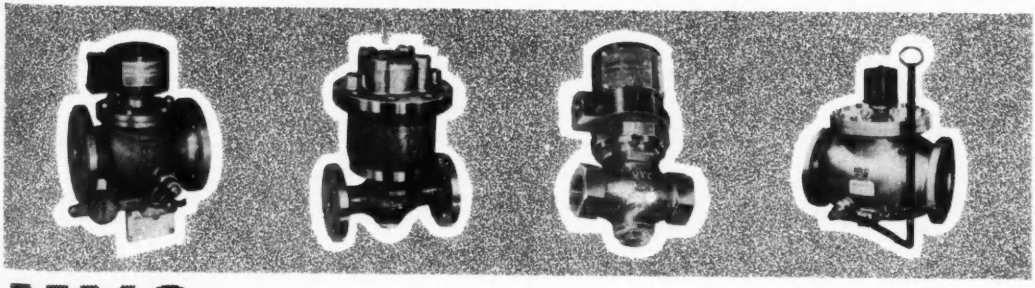
WE OFTEN TALK 'SHOP' AT LUNCH

(Because we like to thoroughly digest our customers' problems!)

We like to see a job well done. And we like to see our customers happy!
Getting our teeth deeply embedded into our customer's problems—no matter how specialized and individual—is the backbone of the MVC Service!

Over 30 years' experience and "know-how" has been built-in to our range of over 100 automatic control valves. People control water with them, gas with them, oil with them, steam with them and a host of other industrial liquids and gases too. Mushrooms are grown with them, jam is made with them and ships' cargoes are frozen with them!

You'll find that expert consultation and advice cost you absolutely nothing at MVC. Our full experience is at your disposal. Many times, what has first appeared to be impossible has been achieved. Why not write *now* for our new comprehensive catalogue No. 22 which contains full details of our complete range!

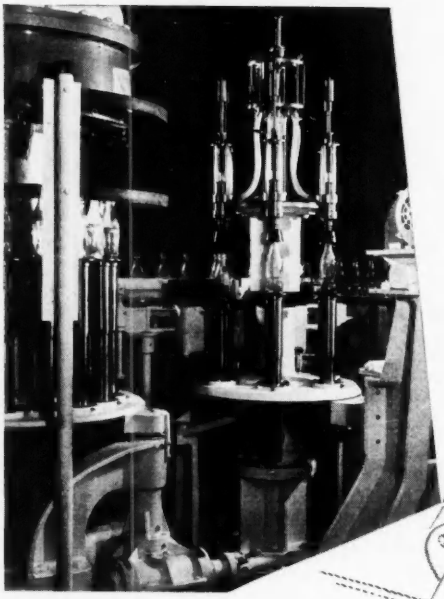


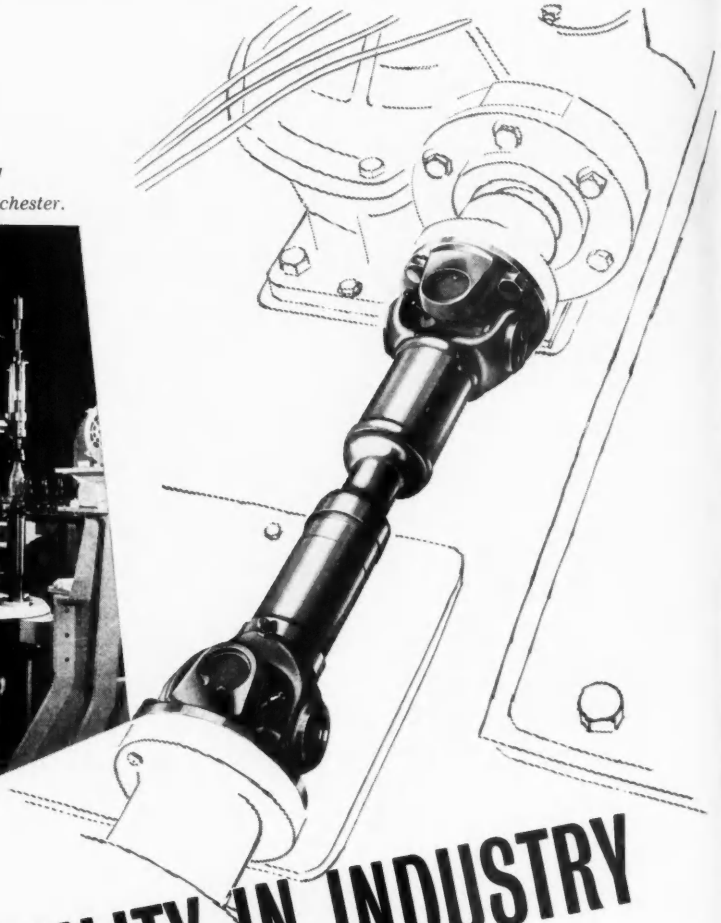
MVC

The Magnetic Valve Company Ltd

7 KENDALL PLACE · BAKER STREET · LONDON · W.1. HUNTER 1801

"Velvaspeed" automatic bottling plant for soft drinks by Bratby & Hinchliffe Ltd., Manchester.





DEPENDABILITY IN INDUSTRY

Well known in the Automotive and Railway Industries, Hardy Spicer are now supplying propeller shafts and universal joints in increasing quantities for other engineering applications. Typical of these is the drive shaft and universal joints used on the Bratby & Hinchliffe Ltd. "Velvaspeed" automatic bottling plant.
Hardy Spicer's wide experience ensures the highest standards of design and performance. Please write for further details and illustrated leaflets.

HARDY SPICER

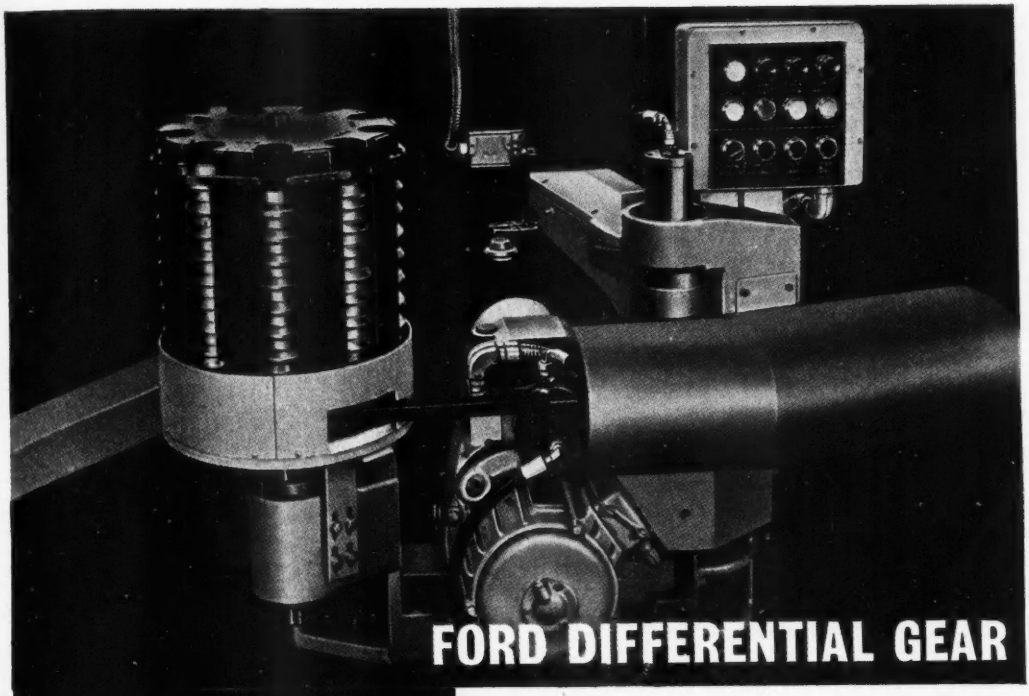
PROPELLER SHAFTS

Member of the Birfield Group

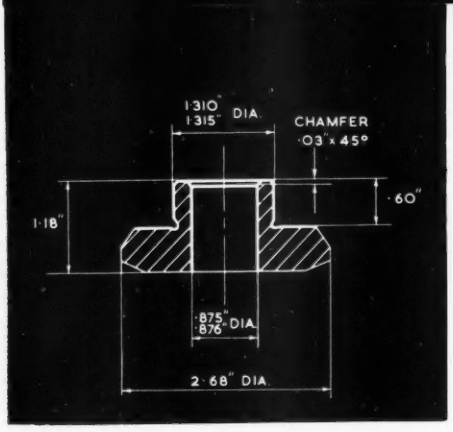
HARDY SPICER LIMITED

CHESTER ROAD, ERDINGTON, BIRMINGHAM 24. ERDINGTON 2191 (18 LINES)

ENGINEERING DIVISION OF BIRFIELD INDUSTRIES LIMITED



FORD DIFFERENTIAL GEAR



MACHINED IN 24 SECONDS WITH AUTOMATIC LOADING

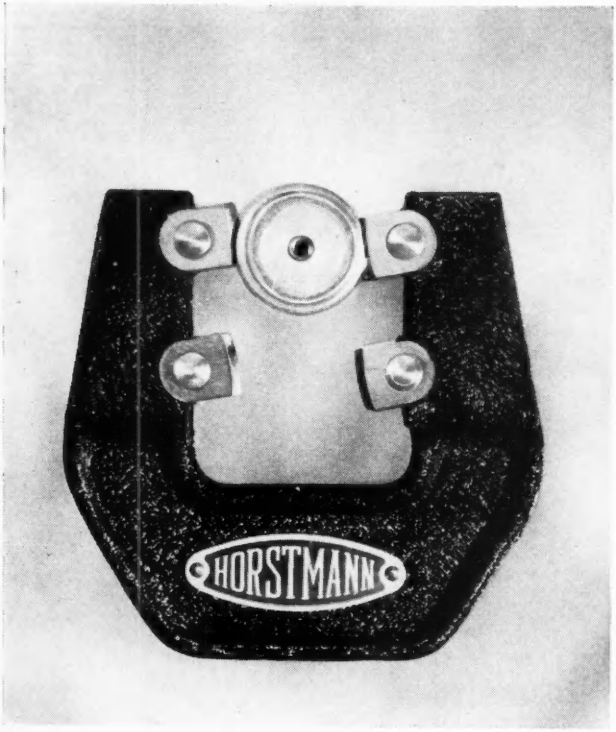
The photograph shows the automatic loader fitted to a No. 6 Ryder Verticalauto supplied to The Ford Motor Company Limited. It is used in the production of differential gears, which are finish-bored, turned and faced at the rate of one component in 24 seconds. The magazine carries enough components for a forty minute run.

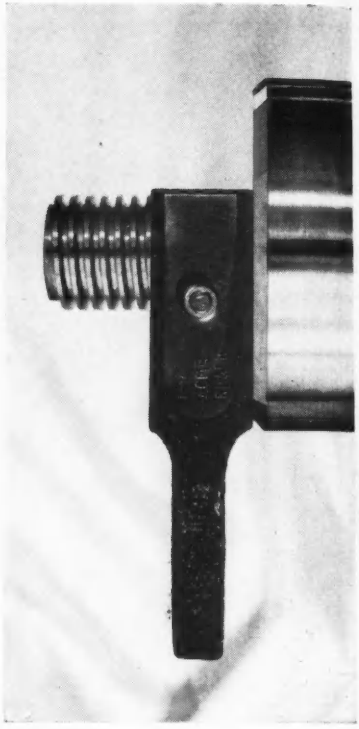
Automatic loading can be fitted to all sizes of Ryder Verticalautos.

Ryder

VERTICALAUTO

Thos. Ryder & Son, Limited, Turner Bridge Works, Bolton, England.
Makers also of single spindle Rydermatics and Piston Ring Lathes.



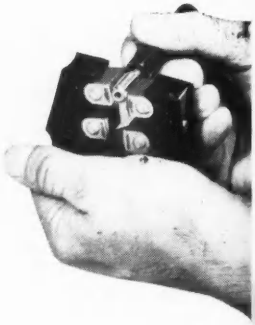


Horstmann—A gauge of accuracy

And—for good measure—the Horstmann Model 52 Screw Caliper Gauge incorporates several features which make it versatile, easy to handle and long-lasting.

One of its advantages (as can be seen from the illustrations) is that there are no projections from the side of the Caliper frame; therefore shouldered work can easily be gauged. Adjusting screws allow for a wide range of work diameters and tolerances, and are used for readjusting to size when the gauge becomes worn. The depth of the anvil section prevents shearing and makes the Horstmann Model 52 ideal for gauging Acme forms of thread. The radiused anvils do not roll and can be used for either left or right hand threaded workpieces. The Caliper is normally supplied as a "GO" and "NOT GO" combination gauge so that both tests can be applied in one action, but is also available as "GO" only or "NOT GO" only. It is manufactured in a full range of B.A., American, Unified, Whitworth, and Metric forms of thread.

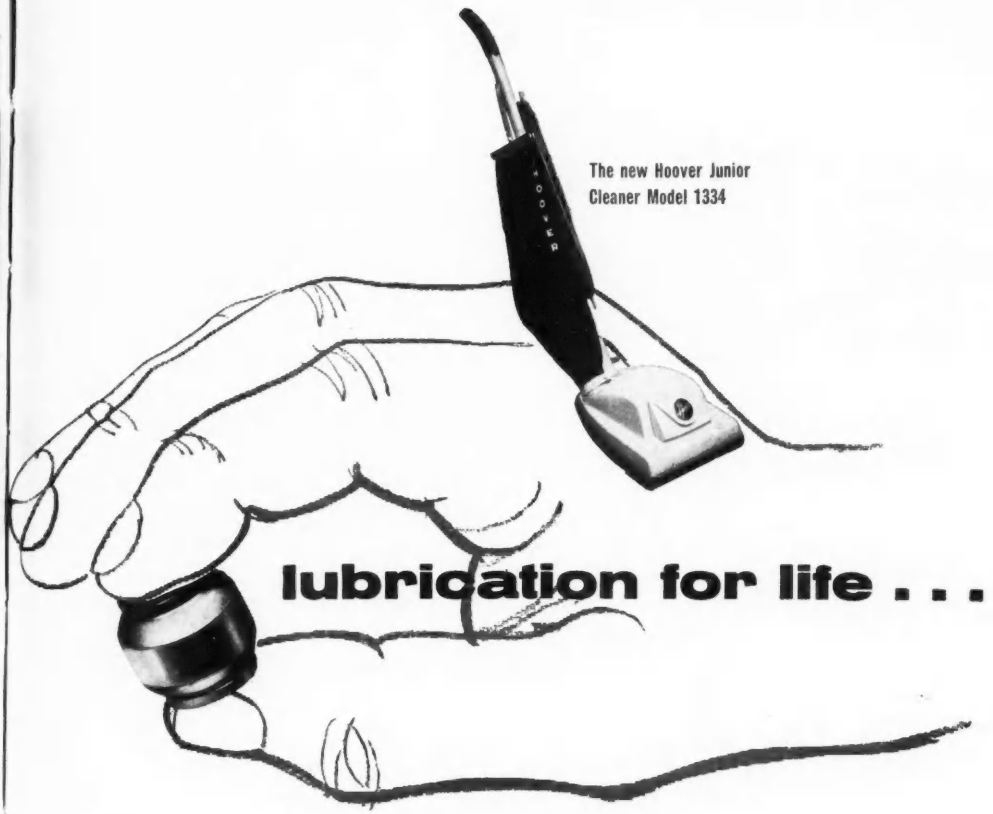
Horstmann also make screw or plain Plug and Ring type gauges. All these precision instruments are guaranteed for accuracy, hardness and finish to the requirements laid down by the National Physical Laboratory and British Standards Institution.
We shall be delighted to send you descriptive leaflets.



HORSTMANN

PLUG, RING & CALIPER GAUGES
put accuracy in your hands.

THE HORSTMANN GEAR COMPANY LIMITED
NEWBRIDGE WORKS, BATH, ENGLAND. Tel.: 7241.



The new Hoover Junior
Cleaner Model 1334

lubrication for life . . .

The production of bearings by the powder metallurgy process is our specialized business. Extensive technical research and development are behind every Lubrook Bearing and enable us to match them to the widening range of mechanical requirements. Powder size analysis, physical testing and extensive running-tests ensure the controlled porosity, structural strength and lubrication capacity of each bearing.
The self-lubricating quality of Lubrook Bronze Bearings overcomes the need for periodic lubrication, making them particularly suited to those less accessible friction points.

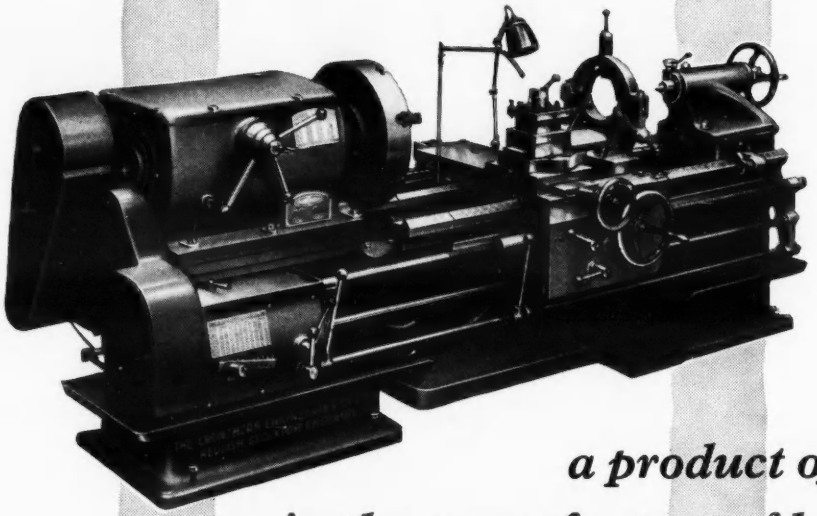
LUBROOK Oil Retaining BEARINGS

Other famous Bound Brook products include:
'Ferrocite' oil-retaining Porous Iron, Bushes, Bearings and Parts.
Sintered Metal Parts and Components by Powder Metallurgy.
Graphited Bronze Bearings.
Sintered Brass Parts.
'Polyslip' P.T.F.E. Impregnated Bearings.
Bound Brook Bronze Filters.

Bound Brook Bearings Limited
TRENT VALLEY TRADING ESTATE, LICHFIELD, STAFFS.
Telephone: Lichfield 2027-8 · Telegrams: Boundless, Lichfield.

Member of the
Birfield Group

All work comes alike to a Crowthorn



The new 10½ in. H.D. lathe enhances still further the Crowthorn reputation for versatility and quality. Extra strength and improved design are matched by many entirely new features, for example :

Larger hollow spindle, 3⅛ in. bore.
Larger gap 36 in. swing × 15½ in. width.
Completely redesigned bed.
Larger and more powerful headstock for heavier cuts and higher speeds.
Redesigned tailstock
Electric suds pump.

Please write for detailed literature on this outstanding new lathe.

the new

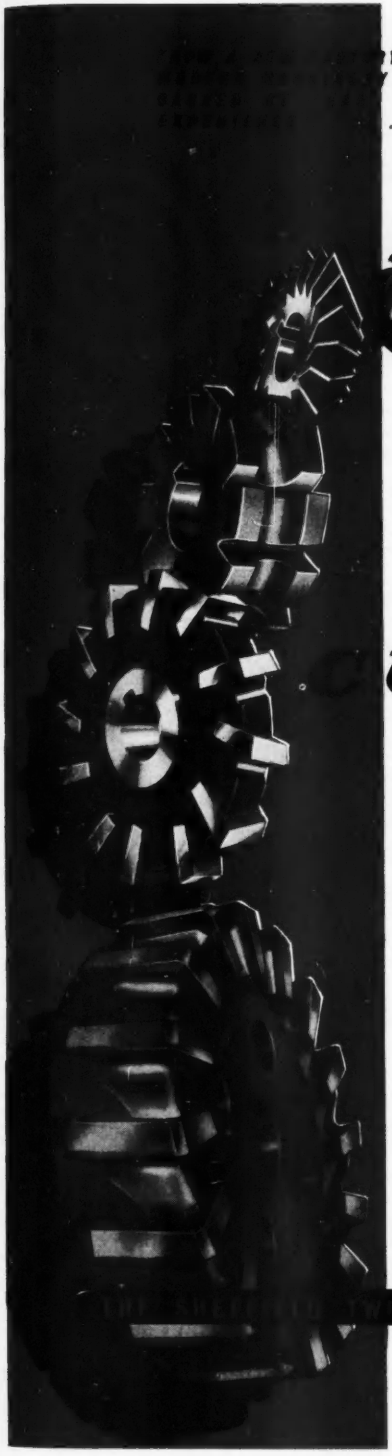
10½″ (21″ swing) H.D. Model CENTRE LATHE

a product of 50 YEARS experience in the manufacture of high class machine tools

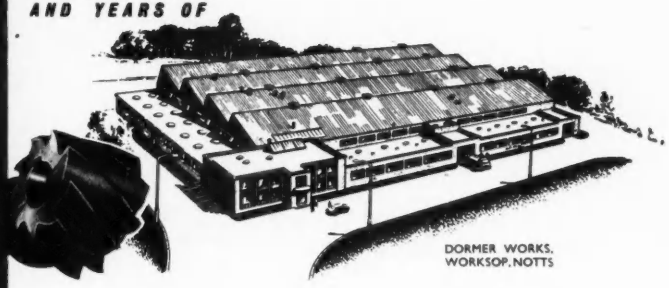
Other famous models in the Crowthorn range include Centre Lathes from 7½ in. to 20 in. centres, 30 in. and 36 in. swing Boring and Facing Lathes with square or hexagon turrets, combination Turret Lathes and 19½ in. stroke Shaping Machines.

CROWTHORN
HIGH CLASS MACHINE TOOL MAKERS

CROWTHORN ENGINEERING COMPANY LIMITED
REDDISH • STOCKPORT • ENGLAND
Phone: STOCKPORT 7271-2-3 Grams: CROWTOOL REDDISH



...Y WITH THE MOST
... AND KNOW-HOW,
... AND YEARS OF



DORMER WORKS,
WORKSOP, NOTTS

...UTTERS by

DORMER

SOLID AND INSERTED TOOTH CUTTERS IN A COMPREHENSIVE RANGE OF TYPES AND SIZES

★ Many are immediately available from stock
Send for Brochure and Stock List

...TWIST DRILL AND STEEL COMPANY LTD.

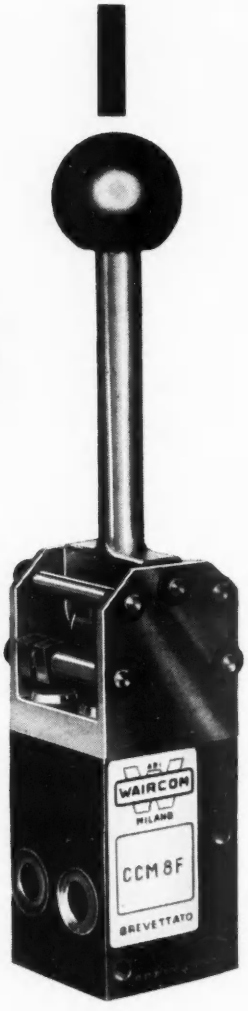
SUMMERFIELD ST. SHEFFIELD 11
Phone: 29181 (10 lines) Grams: PROELLS, SHEFFIELD

DORMER CUTTERS ARE AVAILABLE THROUGH
YOUR USUAL ENGINEER'S TOOL SUPPLIERS

API
WAIRCOM
di Dott. Ing. P. L. PANIGATI

milan,
italy

via maestri campionesi, 17
tel. 58.03.68



industrial

pneumatic

equipment

pneumatic controls
pneumatic valves
pneumatic cylinders
special couplings for compressed air
development of pneumatic plant

There's talk of Sykes in the boardrooms...

The works director of a well-known British company recently telephoned the Sykes factory at Staines. He explained that his firm wished to increase the horse-power of an existing engine without altering the structural design of the gear box. Was it possible, he wanted to know, to achieve this by the use of Sykes double-helical gears; would the consequent increased power give rise to undue noise and vibration; and, most important, would the modification step up his production costs?

Fortunately for him, this was the sort of problem which Sykes are exceptionally well qualified to tackle. Years of work at their main business of supplying first-class gear generating equipment—hobbers, shavers, shapers, cutters—have left them with a rich store of practical experience and expert knowledge. And through their Technical Sales Advisory Service, this accumulated knowledge is available to anyone who wishes to benefit from it.

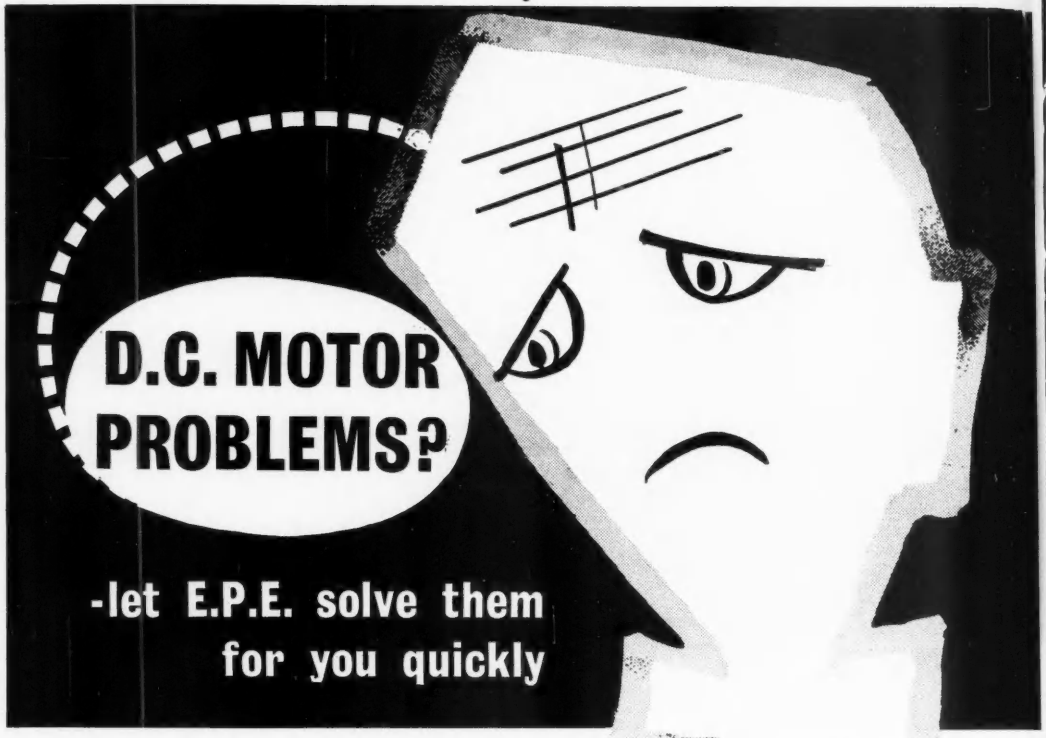
In this particular case, for example, Sykes sent a technical representative to examine the designs for the job. As a result Sykes advised certain additional modifications to the gears; and then—although this was not strictly in their field—their long experience enabled them to suggest how any possibility of noise problems could be avoided by a small internal adjustment to the housing.

Talk to SYKES about gear production

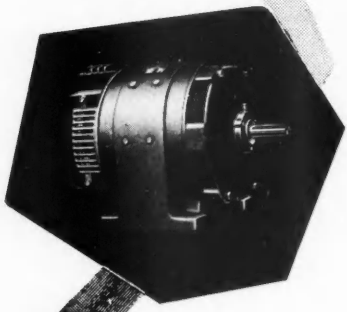
W. E. SYKES LTD · STAINES · MIDDLESEX · ENGLAND and associated companies: Sykes Tool Corporation Ltd, Georgetown, Ontario, Canada
Sykes Machine & Gear Corporation, Newark, NJ, USA
W. E. Sykes Ltd, Mascot, Sydney, NSW, Australia

D.C. MOTOR PROBLEMS?

-let E.P.E. solve them for you quickly



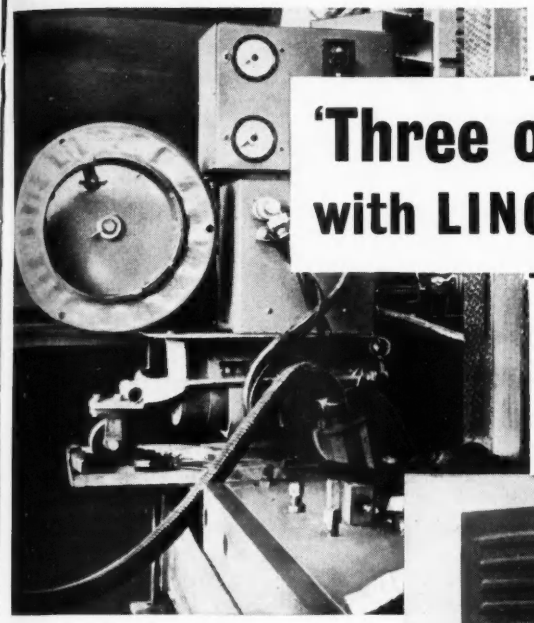
In these days of AC it is not always easy to get DC motors and generators quickly and at a reasonable price. Fortunately, EPE specialise in DC equipment, bringing years of experience to bear on the subject, so that one can always be sure of DC motors and generators, of any enclosure, at competitive prices, on short delivery. EPE are always happy to help solve DC problems, too.

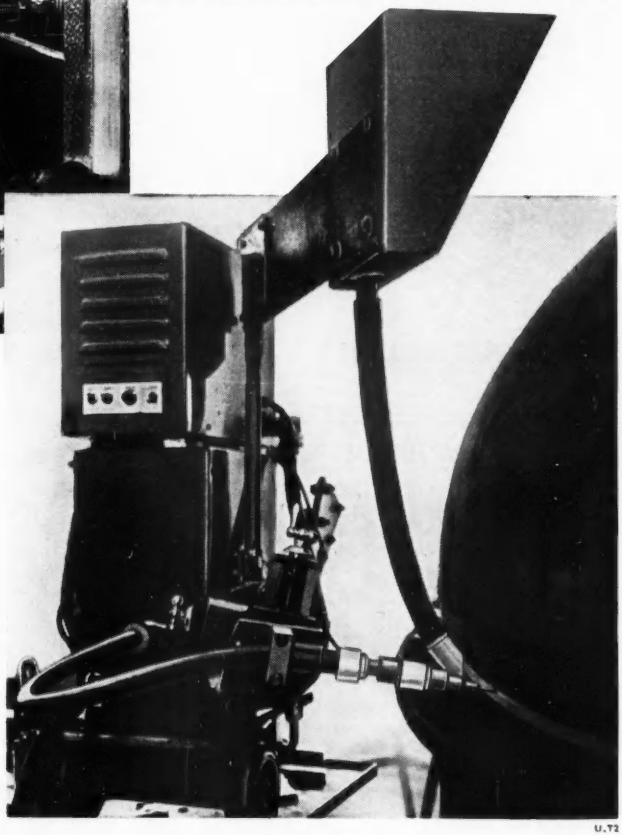


E·P·E

ELECTRICAL POWER ENGINEERING CO. (B'ham) LTD.
Bromford Lane, Birmingham 8
'Phone: STEchford 2261
'Grams: Torque 'Phone Birmingham
London Office: 421, Grand Buildings, Trafalgar Square, W.C.2. 'Phone: WHitehall 5643 and 7963

'Three o'clock' welding with LINCOLNWELD





THE LINCOLNWELD *FINEWIRE* Universal Tractor in action at the Derby works of International Combustion Co. Ltd. The illustrations show the Universal Tractor automatically welding in the '3 o'clock' position, a section of one of 4 heat exchangers for The Advanced Gas Cooled Reactor, being built at Windscale, Cumberland, for the United Kingdom Atomic Energy Authority. (Photographs by the courtesy of International Combustion Co. Ltd. and U.K.A.E.A.)

U.T2

Butt welding, Fillet welding, Lap welding and now horizontal/vertical '3 o'clock' welding—all are possible with the latest LINCOLNWELD *FINEWIRE* UNIVERSAL TRACTOR Submerged Arc Welding Unit.

Don't spend money—make money with Lincolnweld! For further details of how Lincolnweld extra versatility can help solve **your** welding problems, please write to:

A MEMBER OF THE GKN GROUP OF COMPANIES

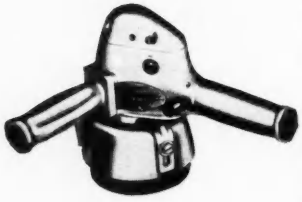
LINCOLN ELECTRIC COMPANY LIMITED

WELWYN GARDEN CITY · HERTS · ENGLAND · Telephone: WELWYN GARDEN 920/4 · 4581/5

Ingersoll-Rand

air powered hand tools for industry

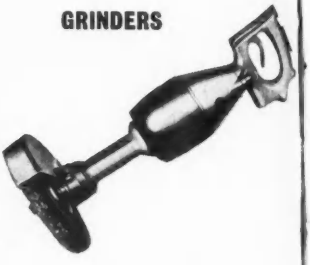
BRITISH MADE



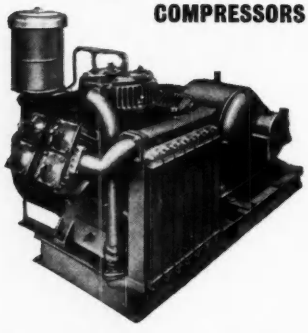
SURFACE GRINDERS

CHIPPING HAMMERS

GRINDERS

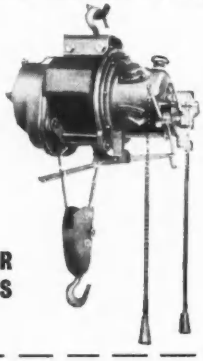


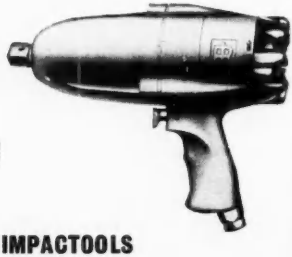
COMPRESSORS



SAND RAMMERS

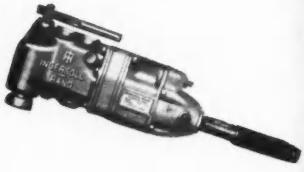
MOTOR HOISTS





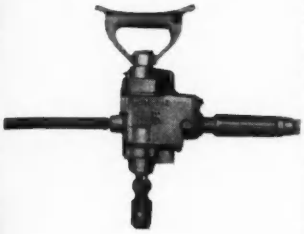
IMPACTOOLS

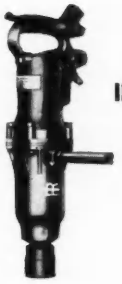
WELD FLUX SCALERS



CLOSE QUARTER DRILLS

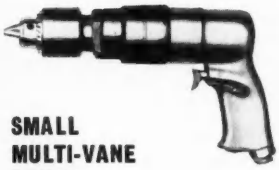
MULTI-VANE DRILLS





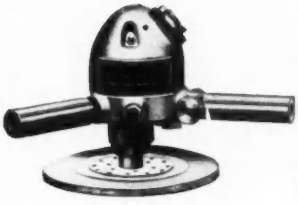
IMPACTOOLS

SCALING HAMMERS



SMALL MULTI-VANE DRILLS

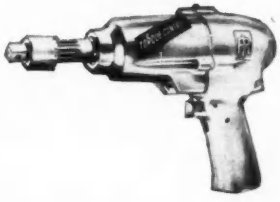
SANDERS



IMPACTOOLS

MULTI-VANE DRILLS

TORQUE CONTROL IMPACTOOLS



Ingersoll-Rand hand-held power tools are made and designed specifically for the following industries. Please tick the industry with which you are concerned. Descriptive literature will be mailed to you by return.

- Oil and Petroleum ☐
- Iron and Steel ☐
- Fabricated Metals ☐
- Automobile ☐
- Aircraft ☐
- Railway ☐
- Ship and Boat Building ☐
- Machinery (Mechanical) ☐
- Machinery (Electrical) ☐
- Mining ☐
- Public Utilities (Electricity, Gas, Water, Telephone, etc.) ☐

NAME .....

COMPANY'S NAME .....

ADDRESS .....

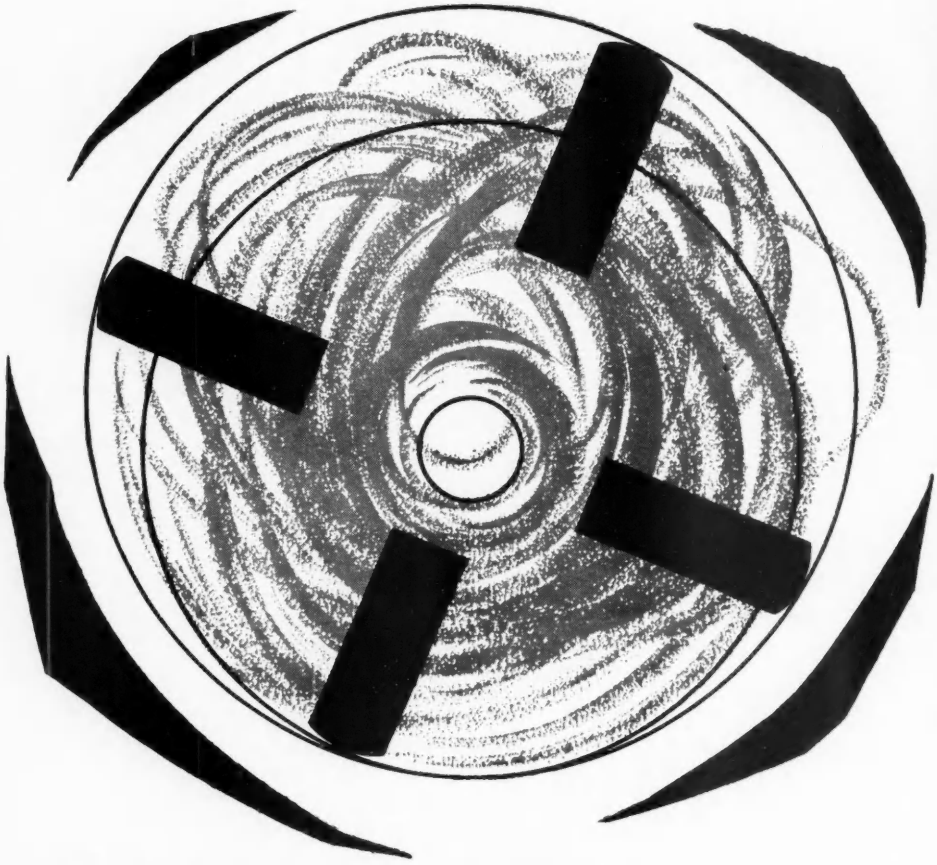
Power in hand with—

Ingersoll-Rand

INGERSOLL-RAND COMPANY LIMITED

165 QUEEN VICTORIA STREET LONDON EC4 Tel: CEN 5681
SCOTTISH OFFICE: 20 RENFREW STREET GLASGOW C2
Tel: DOUGLAS 1233 Grams: INGERSOLL GLASGOW

P.2899



CARBON VANES ARE DIFFERENT!

Light as aluminium, non-hygroscopic, readily machineable, highly resistant to wear and requiring no lubrication—these are some of the special properties of MORGANITE CARBON VANES. They are especially suitable for use in rotary pumps and compressors where non-contamination is essential.

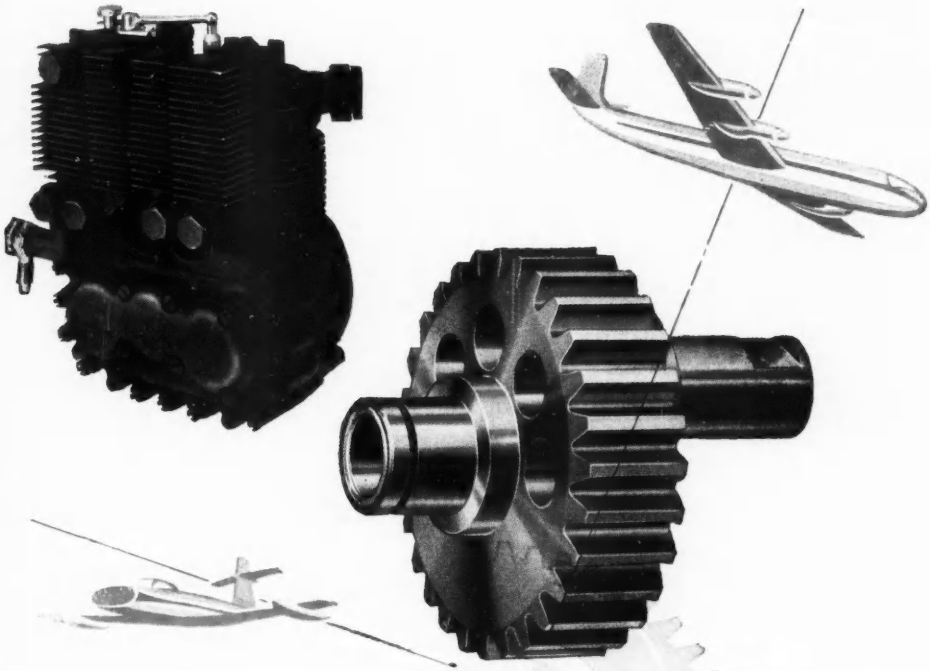
MORGANITE CARBON VANES resist chemical atmospheres and corrosive conditions; withstand high temperature, immersion in liquids; are suitable for inaccessible positions and completely eliminate maintenance.

MORGANITE CARBON VANES are solving the specific problems of many manufacturers—maybe they will solve yours. Please write or telephone for leaflet SD 69, or for one of our Technical Advisers to call.

MORGANITE VANES

C68a

THE MORGAN CRUCIBLE COMPANY LIMITED
BATTERSEA CHURCH ROAD, LONDON, S.W.11. **Telephone: BATtersea 8822**



GEARED FOR HIGH PRESSURE ... for DUNLOP

Dunlop put their trust in geared crankshafts which drive this small but powerful compressor in aircraft actuated systems. Each compressor supplies 3,200 p.s.i. storage pressure at 3,200 r.p.m., yet weighs only 10 lb.

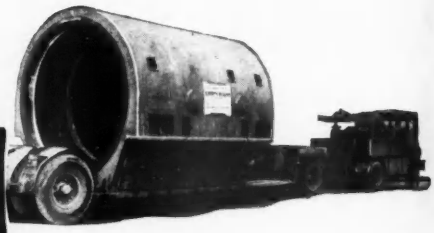
Have you had literature on our Gear Grinding Service and Gear Grinding machines? It's yours for the asking.

The Gear Grinding Co. Ltd.

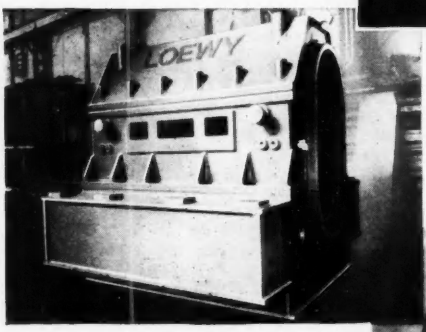
Makers of the "ORCUTT" range of gear and spline grinding machines and gear measuring machines

CRANMORE BOULEVARD · SHIRLEY · SOLIHULL · WARWICKSHIRE

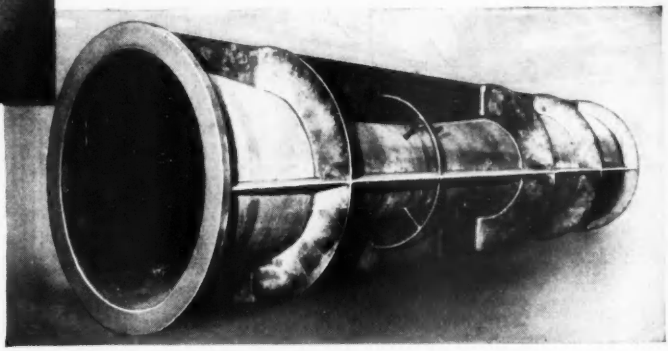
Heavy Welded Fabrications



For the ultimate in Welded Fabrications consult Empyrium, pioneers in this field.



Transformer and Switchgear Tanks; Storage Tanks for Petrol, Oil and Water; Autoclaves; Chemical Plant of all descriptions; Bedplates; Machine Tool and Press Frames; Gas Works Plant; Hoppers, Condensers, Gear Guards, Blast Mains, Air Receivers and Pressure Vessels of all types.



Empyrium fabricate for all industries to ASME and Lloyds specification. Also to the exacting requirements of the Petroleum and Oil Companies. Full testing facilities, including X-Ray.

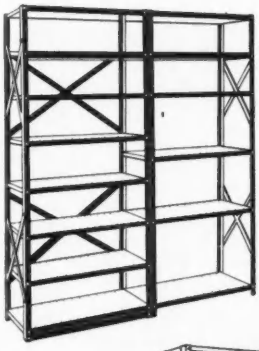
EMPYRIUM
WELDING & MANUFACTURING COMPANY LIMITED

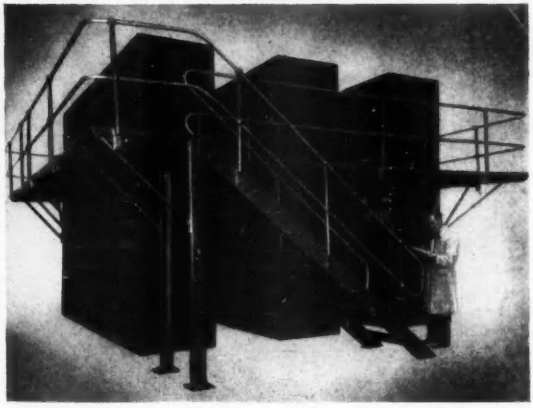
Head Office and Main Works: Pritchett Street, Birmingham 6.
Telephone: ASTon Cross 3203/4/5.
Telegrams: Empyrweld Birmingham.

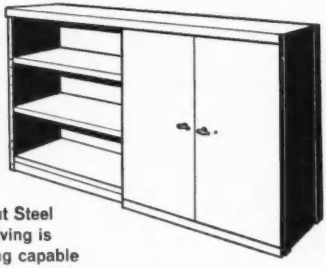
PIONEERS IN WELDING PRACTICE SINCE 1917

JW. Ad 4680

SHELVING YOUR PROBLEM







If the problem is storage there's an economical answer—Evertaut Steel Shelving. Available in a multi-purpose range Evertaut Steel Shelving is space-planned for efficiency, the units within each category being capable of infinite variation in arrangement. The range includes open type, closed type, light warehouse shelving, multi-tier shelving, ledge type, counter shelving, Hinged and sliding doors are included in the range.

EVERTAUT
STEEL SHELVING

POST COUPON FOR CATALOGUE!

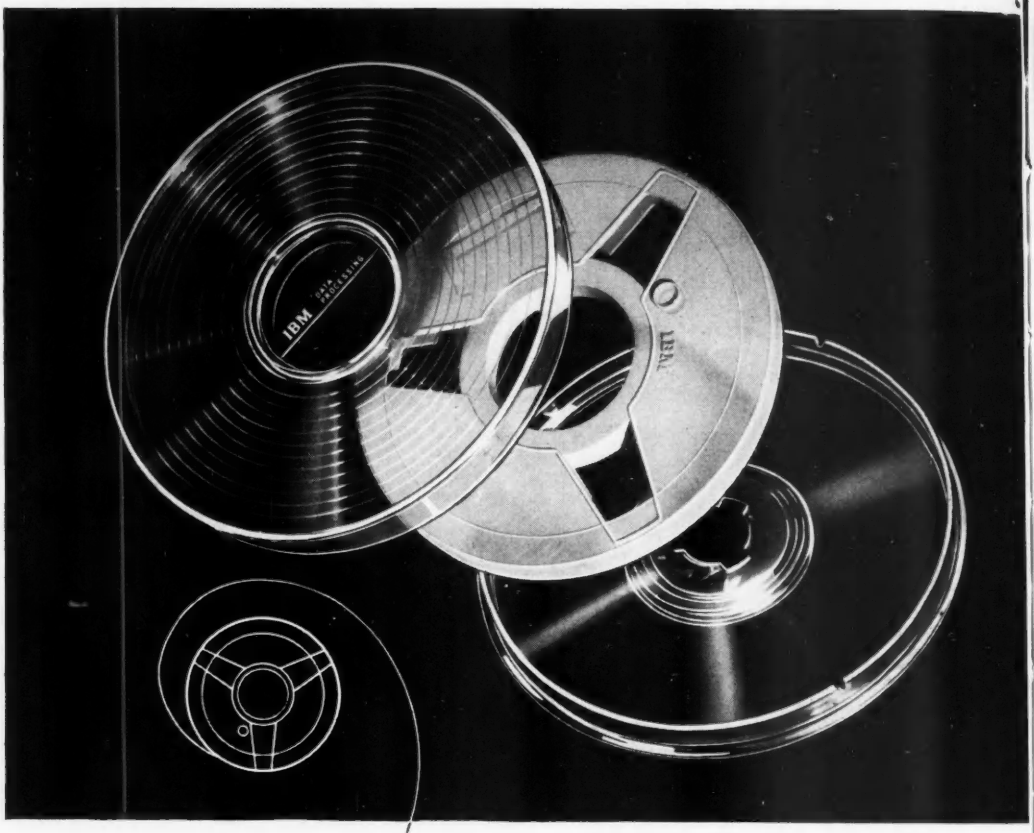
To: Evertaut Ltd., Walsall Road,
Perry Barr, Birmingham, 22B.

*Please send me your **Shelving Catalogue**.*

NAME_____

ADDRESS_____

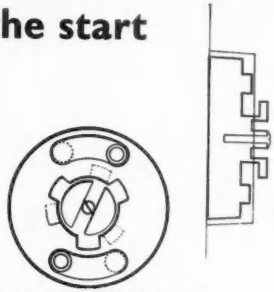
_____ E



we had this taped from the start

Amongst the large number of moulding jobs we have carried out we include this 12″ Magnetic Tape Reel and Transparent Dust Proof Cover* as one of the more interesting.
The moulding is a typical example of accuracy combined with size and attractive appearance. One of the salient features in the moulding is the fitting of the top cover to the base by three latches. A PTFE Washer (.005″) was included which eliminated the need for lubrication.
Easy opening and closing was assured.
An interesting factor is the range of material used:

Covers: *Clear Polystyrene.*
Reels: *High Softening Medium Impact Polystyrene.*
Card Holder: *High Impact Polystyrene.*
Latch Mouldings: *Graphite Loaded Polystyrene.*
Locking Ring: *Polythene.*
Washer *P.T.F.E.*



★ *Produced for I.B.M. United Kingdom Ltd., one of our many friends and customers.*

With four factories at our disposal each equipped with the most modern machines, we can undertake practically any compression, injection or moulding job, however long the run.
We should be pleased to hear about your moulding problems —we can help you.

E. Elliott Limited

The plastic moulders with the engineering background

315, Summer Lane, Birmingham 19, Tel: ASTon Cross 1156/7/8/9

—for toolroom or high production milling of small parts the—

EDGWICK

N°1 SIMPLIMIL

fitted with an all-geared drive assembly featuring . . .

- NICKEL-CHROME HEAT-TREATED SPINDLE WITH FLYWHEEL.
- PRECISION SPINDLE BEARINGS—LOCKED INNER AND OUTER RACES
- HERBERT PATENTED QUICK RELEASE COLLARS FOR PICK-OFF GEARS
- DOUBLE WALL CONSTRUCTION
- SHORT STURDY SHAFTS

Choice from two ranges of six speeds 60-540 r.p.m. or 224-2020 r.p.m. On automatic machine alternative range of feeds—five feeds from $\frac{1}{2}$" to 3" per min., or three feeds, $3\frac{7}{8}$", 6" and $9\frac{7}{8}$" per min.

A529

TWO MODELS AVAILABLE
HAND FEED: 7" x $3\frac{1}{4}$" x 9"
AUTOMATIC FEED: 10" x $3\frac{3}{4}$" x 13"

ALFRED HERBERT LTD., COVENTRY Factored Division, Red Lane Works.

AD.547

NEW outstanding features!

The high accuracy of this 5in. by 12in. Capacity machine lends itself equally for toolrooms or production operations.

JONES & SHIPMAN

on model 1212

5in. × 12in. Capacity

Its new design includes many features for producing the highest precision results in cylindrical grinding, all of which are fully described in Brochure No. 255 on application.

WHEEL-SPINDLE

Bearing pressures temperature controlled according to spindle speeds.

BACKSLIDE

Unique slideway support system with submerged lubrication to all parts.

WORKHEAD

Live spindle design with internal cone seating.

INTERNAL GRINDING

An optional feature enabling maximum capacity between chuck and wheel.

A. A. JONES & SHIPMAN LTD.,
LEICESTER
Telephone: 823222
London Office: 50/52 Great Peter Street, London, S.W.1. Tel: Abbey 5903/9

J & S

High Speed + Flexibility

The **Steadfast** Flexible High Speed hacksaw blade is hardened on the teeth only by a new technique, giving cutting performance equal to the normal "all hard" high speed blade. At the same time it imparts a flexibility which enables the blade to be used by the unskilled, without fear of breakage.

The **Steadfast** Flexible High Speed blade will cut the toughest type of steel and withstands considerable mis-use, making it eminently suitable for "difficult" jobs which require flexibility allied to maximum cutting power.

For economy and efficiency, there is none better than the **Steadfast** Flexible High Speed blade.

Steadfast
FLEXIBLE HIGH SPEED

Available in the following sizes at the same prices as all other High Speed hacksaw blades.

LENGTH	WIDTH	THICKNESS	PITCHES OF TEETH
10"	½"	·025"	18, 24, 32
12"	½"	·025"	14, 18, 24, 32

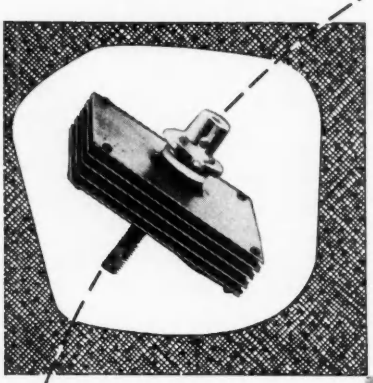
TOLEDO
DARWINS TOOL DIVISION
SHEFFIELD
Steadfast

DARWINS TOOL DIVISION

J. STEAD & CO. LTD. MANOR WORKS, SHEFFIELD, 2.

Greater Efficiency

at lower D.C. voltages



with HEWITTIC GERMANIUM RECTIFIERS

EMPLOYING HEWITTIC DIODES

Greater efficiency — much greater at low voltages — plus reliability are features of Hewittic germanium rectifiers — designed and produced throughout against a rectifier engineering background of over 50 years. The illustrations show a Hewittic air cooled germanium diode and a 400 kW 230-0-230 volt D.C. (3 wire) Hewittic germanium rectifier for general workshop supply at the Crewe Locomotive Works, British Railways, London Midland Region. Silicon equipments can also be supplied.

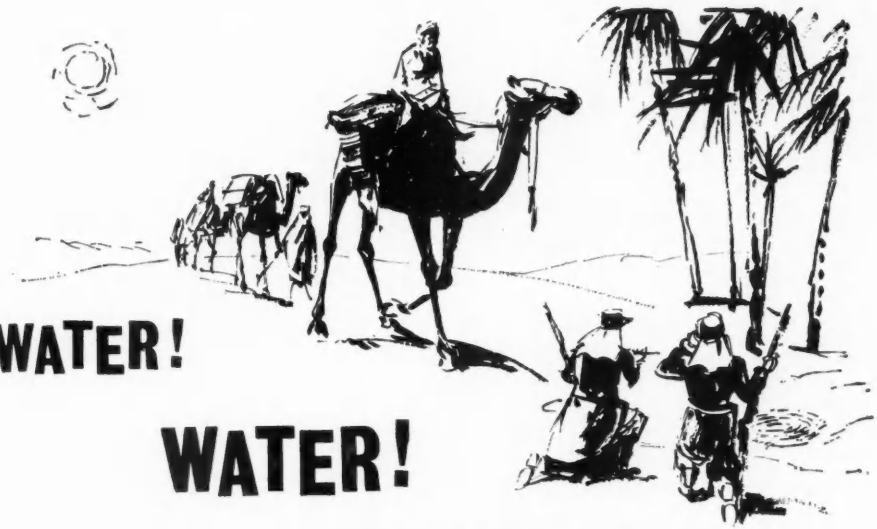
Send for Publication R.193.

HACKBRIDGE & HEWITTIC ELECTRIC CO., LIMITED

WALTON-ON-THAMES, SURREY, ENGLAND

Telephone: Walton-on-Thames 28833 (8 lines) *Telegrams & Cables: "Electric, Walton-on-Thames"*

OVERSEAS REPRESENTATIVES. ARGENTINA: H. A. Roberts & Cia., S.R.L., Buenos Aires. AUSTRALIA: Hackbridge and Hewittic Electric Co. Ltd., 171, Fitzroy Street, St. Kilda, Victoria; N.S.W.: Queensland: W. Australia, Elder, Smith & Co. Ltd.; South Australia: Parsons & Robertson Ltd.; Tasmania: H. M. Bamford & Sons (Pty.) Ltd., Hobart. BELGIUM & LUXEMBOURG: Pierre Pollie, Brussels 3. BRAZIL: Oscar G. Mors, Sao Paulo. BURMA: Neonlite Manufacturing & Trading Co. Ltd., Rangoon. CANADA: Hackbridge and Hewittic Electric Co. of Canada Ltd., Montreal; The Northern Electric Co. Ltd., Montreal, etc. CEYLON: Envee Ess Ltd., Colombo. CHILE: Sociedad Importadora del Pacifico Ltda., Santiago. EAST AFRICA: G. A. Neumann, Nairobi. EGYPT: Giacomo Cohenca Fils, S.A.E., Cairo. FINLAND: Sähkö-ja Koneliike O.Y. Hermes, Helsinki. GHANA, NIGERIA & SIERRA LEONE: Glyndova Ltd. GREECE: Charilaos C. Coroneos, Athens. INDIA: Steam & Mining Equipment (India) Private Ltd., Calcutta; Easun Engineering Co. Ltd., Madras 1. IRAQ: J. P. Bahoshy Bros., Baghdad. MALAYA: SINGAPORE & BORNEO: Harper, Gilfillan & Co. Ltd., Kuala Lumpur. NETHERLANDS: J. Kater E. I., Ouderkerk a.d. Amstel. NEW ZEALAND: Richardson, McCabe & Co. Ltd., Wellington, etc. PAKISTAN: The Karachi Radio Co., Karachi 3. SOUTH AFRICA: Arthur Trevor Williams (Pty.) Ltd., Johannesburg, etc. CENTRAL AFRICAN FEDERATION: Arthur Trevor Williams (Pty.) Ltd., Salisbury. THAILAND: Vichien Phanich Co. Ltd., Bangkok. TRINIDAD & TOBAGO: Thomas Peake & Co., Port of Spain. TURKEY: Dr. H. Salim Öker, Ankara. U.S.A.: Hackbridge and Hewittic Electric Co. Ltd., P.O. Box 234, Pittsburgh. 30, Pennsylvania. VENEZUELA: Oficina de Ingenieria Sociedad Anonima, Caracas.



WATER!

WATER!

WATER!

NOW

IS THE TIME TO PREPARE FOR THIS SUMMER

HEENAN *Water Coolers*

ELIMINATE SHORTAGES, LOSS OF PRESSURE, RATIONING

1959 saw one of the greatest shortages of water that this country has ever experienced. It could happen in 1960—or any other year.

Do not risk your output being hampered or your business shut down, through reduction of town-water pressure, or actual cutting-off of supplies.

The Heenan Water Cooler uses the same cooling water over and over again. Be independent of the town's water supply—INSTALL NOW. Apart from all these advantages

THE HEENAN COOLER QUICKLY PAYS FOR ITSELF

H&F

HEENAN & FROUDE LTD., ENGINEERS, WORCESTER

The ONLY

British Designed & Built

Jig Grinding Machine

MATRIX
COVENTRY GAUGE & TOOL COMPANY LTD

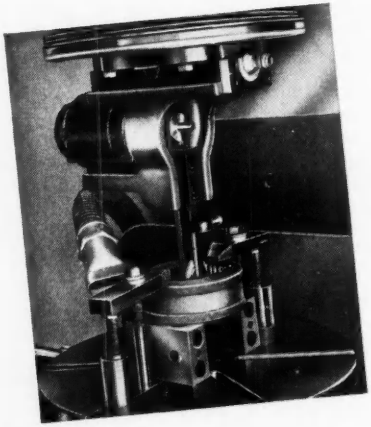
QUALITY

No. 56/12 x 18

This machine, the only Jig Grinder designed and built in this country, is a product of the Coventry Gauge & Tool Co. Ltd. who have unique experience in designing and manufacturing both Jig Boring and precision Grinding Machines.

This machine is fitted with a high frequency spindle which *maintains a constant speed irrespective of load.*

Use the '56' for the accurate grinding of straight and tapered holes and regular and irregular straight or tapered contours and make substantial economies in the grinding of press tools, precision jigs and fixtures.



SPLINE AND SLOT GRINDING ATTACHMENT

Another outstanding feature is the slot grinding attachment incorporati a micrometer adjusted compound slide. This enables corrections to made without moving compound table or disturbing coaxial setting circular table in relation to quill.

BRIEF SPECIFICATION

Table working surface	18" x 12"	Max. hole grinding size	5" d
Quill rotation speed	25-255 r.p.m.	(9" dia. with special adaptor pla	
Grinding Wheel speed	12,000-50,000 r.p.m.	Max. Quill travel	4"
		Vernier readings	.0001"

Sole Agents in U.K.

ROCKWELL
MACHINE TOOL CO. LTD

For further particulars write or telephone TODAY

WELSH HARP, EDGWARE RD., LONDON, N.W.2. TEL: GLADSTONE 00

ALSO AT BIRMINGHAM—TEL: SPRINGFIELD 1134/5 • STOCKPORT—TEL: STOCKPORT 5241 • GLASGOW—TEL: MERRYLEE 22

Matrix 6

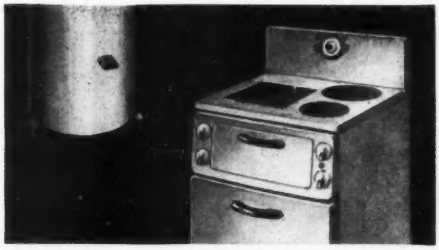
New Luxol Acrylic Stoving Finish

Almost as hard as Vitreous Enamel!

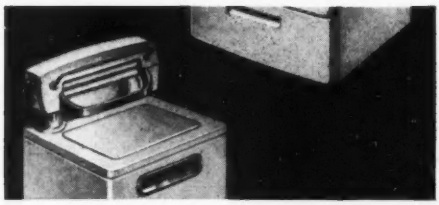
Here is a new, harder, tougher stoving finish than has ever before been available to manufacturers and processors of domestic and industrial equipment.

In terms of hardness Luxol Acrylic Stoving Finish is almost comparable to vitreous enamel, though considerably cheaper and less liable to chip during assembly. It brings a new improved standard of protection to every type of product. Colours are crisper, cleaner and possess exceptional stability; white is really white *and will not yellow with age.*

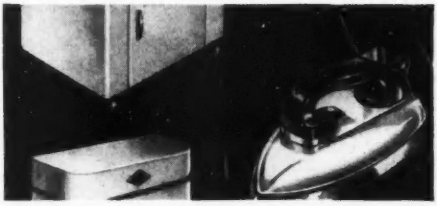
Moderate overbaking has no effect upon Acrylic colours; fewer rejects contribute still further to reducing production costs.



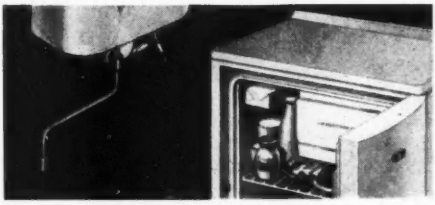
Perfect colour retention



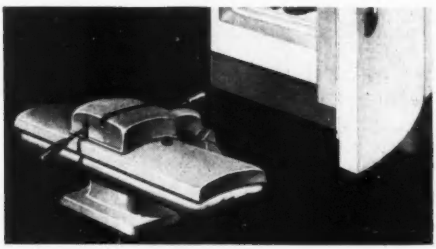
Brilliant clarity of colours



Greater impact resistance



Increased durability



Luxol Acrylic Stoving Finish offers much to a great variety of products.

REFRIGERATORS—Longer, smarter life with its increased toughness plus flexibility, perfect colour retention and new colour brilliance.

WASHING MACHINES—Greater durability with superior stain and detergent resistance.

GAS AND ELECTRIC COOKERS AND WATER HEATERS, ELECTRIC IRONS—Now more efficient with a finish that is unaffected by temperatures between 350° - 400° F.

HOSPITAL, KITCHEN AND BATHROOM EQUIPMENT, METAL FURNITURE—All improved products with the ability to maintain their immaculate appearance throughout years of use.

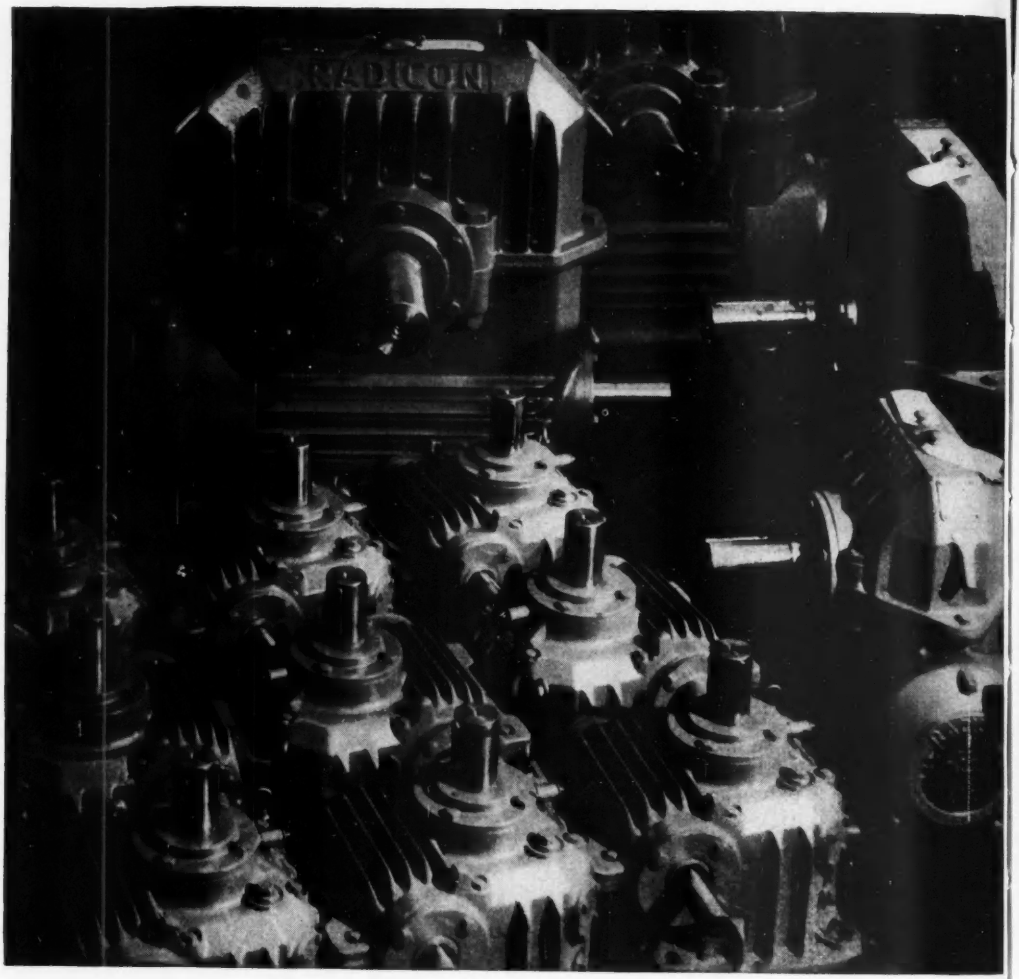
Luxol Acrylic Stoving Finish does not interfere in any way with existing production systems.

BRITISH PAINTS LIMITED

INDUSTRIAL FINISHES DIVISION

Portland Road, Newcastle upon Tyne, 2.
Northumberland House, 303-306 High Holborn, London, W.C.1
31, Wapping, Liverpool.

Belfast · Birmingham · Bristol · Cardiff · Glasgow · Leeds · Manchester · Norwich Plymouth · Sheffield · Southampton · Swansea and all principal towns.



Radicon—the quick answer on speed reduction

The quickest way to solve your speed reduction problems is to call in David Brown. Their stock range of RADICON speed reducers covers all reasonable requirements and offers for your choice, 330 combinations of type, size and ratio in standard units from 2¼ to 14—available for despatch within 24 hours.

Behind every 'Radicon' there are 100 years of sound technical and production experience. In front of every 'Radicon' there is a long, long life of hard, hard work.

If your problem is urgent, write for catalogue F.487.20. If it's desperate, please telephone.

DAVID BROWN

An alliance of engineering specialists in gearing, machine tools, castings, automobiles, and agricultural tractors and machinery.

THE DAVID BROWN CORPORATION (SALES) LIMITED

OA/3083 RADICON DIVISION, (SIZES 2¼ to 28) • PARK WORKS • HUDDERSFIELD • TELEPHONE: 3500

THE BLUE PAGES

A QUICK GLANCE AT THE LATEST TECHNICAL DEVELOPMENTS THROUGHOUT THE WORLD

• *IMPROVED SPRAY-WELDING MATERIALS*

In spray-welding, a metal is first sprayed onto the surface to be coated, and the coating thus obtained is then fused in place either in a furnace or by means of heating torches. In the past, the spray-welding process has been subject to several limitations, one of the most fundamental of these being due to the tendency of the coatings to run and drip during the fusing operation. This limitation makes it impractical to apply coatings of over $\frac{1}{16}$ in. in thickness, and even this coating thickness can be fused only with great difficulty and only on objects of relatively simple shapes. Objects with sharp corners or grooves give difficulty during the fusing operation, because of the tendency of the coating to flow away from the edges, this tendency being due to the necessity for flux additions to the coating alloy in order to produce sufficiently unoxidized coatings initially.

A new spray-welding material has now been developed which is claimed to overcome the fundamental limitation mentioned above and which may be sprayed with a minimum of oxide formation and yet readily lends itself to the fusing operation, in the sense that it has a materially reduced tendency to run and drip. This material comprises a mixture of at least two powdered metal alloys, one of which must be self-fluxing. Also, there must be a difference in melting temperature of at least 10°F between the self-fluxing alloy and at least one other of the alloys in the mixture. The alloys are so chosen that they are mutually alloyable below the upper limit of the fusion range of the mixture when sprayed. The self-fluxing alloy is preferably a nickel-base alloy, containing at least one member of the group consisting of phosphorus, lithium, and boron.

From *Brit. Pat. Spec.* 826, 181.
Metallizing Engineering Co. Inc., Westbury, N.Y., U.S.A.

• *BONDING CAST IRON TO ALUMINIUM BY DIECASTING*

It has now become possible to bond cast iron to aluminium without having resort to the use of fluxes or precoating with aluminium. This is achieved by a diecasting process in which the pressure exerted in diecasting is used to force the aluminium into the rough surface of the cast-iron component. Applications of this process include cast-iron cylinder liners for aluminium engine blocks, cast-iron brake liners for aluminium drums and wheels, and aluminium cooling fins on cast-iron piston sleeves. The new technique is expected to eliminate existing design restrictions on composite aluminium and cast-iron components. With regard to surface preparation, a simple cleaning treatment of the cast-iron, such as sand-blasting or salt-bath immersion, is recommended, in order to remove the mould coating on the as-cast piece and to expose a rough surface containing a multitude of tiny undercut areas and protrusions. Tumbling or machining of the castings is considered to be unnecessary.

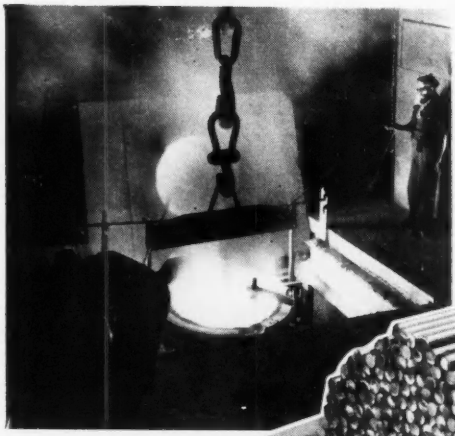
Using a metal temperature of 1200°F and a pressure of 10,800 psi in the diecasting process, the aluminium is forced into the surface irregularities of the cast piece and a firm, interlocking bond is formed, which contains little, if any, of the brittle iron-aluminium alloy. Tests have shown the joint to be both strong and ductile, strength being high both in tension and shear. In the shear test, it was found that interference-fit joints have a strength which is dependent on the roughness of the cast-iron insert, rougher surfaces giving a higher shear strength.

From *Steel*, U.S.A.,
November 30, 1959, pp. 98–100.

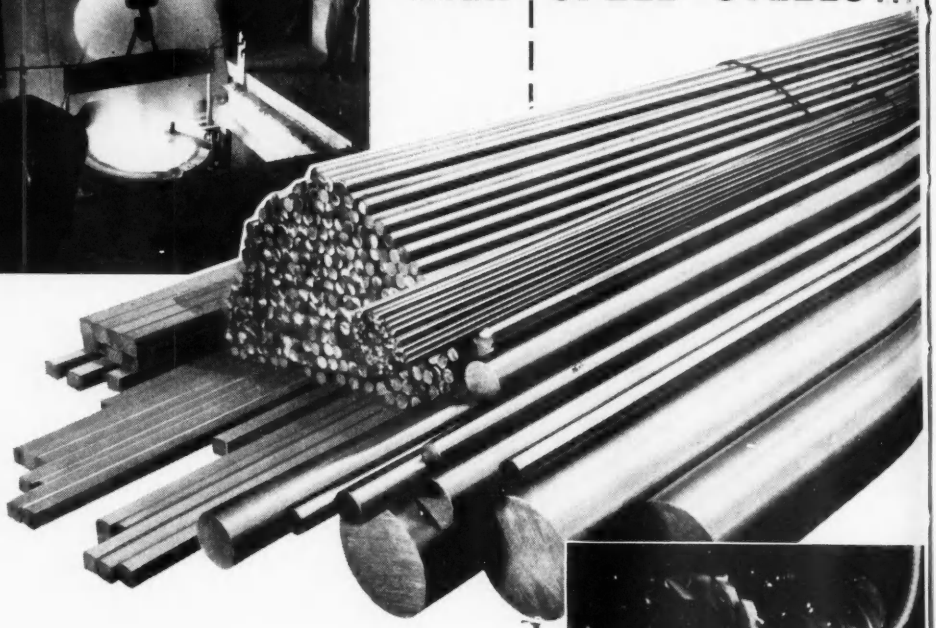
• *TAPER-MEASURING INSTRUMENT*

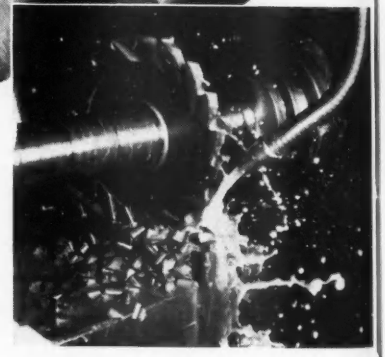
The machining of accurate tapers with the aid of conventional gauging methods is frequently a time-consuming procedure, requiring expensive gauging equipment and mathematical skill. A typical set-up may involve the use of a precision surface plate, gauge blocks, a sine bar, a height gauge, and a dial indicator. More important, however, is the necessity for removing the tapered workpiece from the lathe or grinding machine to measure the taper. If the taper does not fall within the specified limits, it will be necessary to replace the work in the machine and to adjust the latter by the amount the taper is in error. Since the workpiece can rarely be replaced in exactly its previous position on the centres, the adjustment of the machine may now be incorrect, and it may be necessary to remove and replace the workpiece a number of times before the desired taper is obtained.

A new taper micrometer now makes it possible to measure the taper directly and rapidly with a single piece of relatively inexpensive equipment, and without the necessity for remov-



SPEEDICUT
HIGH SPEED STEELS...





...for all cutting tools

The high production rates achieved in cutting both soft and hard materials in the modern machine shop are in a large measure attributable to the efficient use of high speed steel tools.

Firth Brown high speed steels are distinguished among tool materials by their ability to develop by appropriate heat treatment an outstanding combination of the principal characteristics required in cutting tools, namely hot hardness, wear resistance and toughness, enabling them to retain their cutting ability at speeds, feeds and depths of cut.

There is a Firth Brown high speed steel for your every need — write for Publication No. 224 (Section 7) for further details.

by

FIRTH BROWN

ALLOY STEELMAKERS • FORGEMASTERS • STEEL FOUNDERS • HEAVY ENGINEERS

THOS. FIRTH & JOHN BROWN LIMITED • SHEFFIELD • ENGLAND

ing the workpiece from the machine. The new micrometer, incorporating within itself the sine-bar principle, gives the actual value of the taper for small angles. Larger tapers can be obtained from the micrometer readings with no more mathematical knowledge than is needed for converting from included angle to taper. Under production conditions, the desired upper and lower limits for the various tapers to be produced can be readily specified in terms of precise micrometer readings. It is claimed that, with this new instrument, it is possible to inspect tapered parts ten times faster than with conventional methods. Both internal and external taper can be checked without the need for sine bars.

From *The Tool Engineer*, U.S.A., January 1960, pp. 85–87.

● *HIGH-EFFICIENCY TWIN-WORM GEAR SYSTEM*

A dual-worm gear system has been developed which not only provides self-locking with the transmission efficiency maintained at over 90%, but which also exhibits a novel characteristic termed " deceleration locking ". In this twin-worm drive, two threaded rods or " worm " screws are meshed together, the worms being wound in different directions and having different pitch angles. In order to obtain proper meshing, the worm axes are not arranged in parallel but are slightly skewed. By the proper selection of pitch angles, which must be different, the drive will exhibit either self-locking characteristics, or a combination of self-locking and deceleration-locking characteristics, as desired.

Deceleration locking can be described as follows:— When the input gear decelerates, e.g., because the power supply is shut off, or because an outside force is applied to the output gear in its direction of rotation, the entire transmission immediately locks and comes to an abrupt stop, moderated only by any " elastic stretch " that may be present in the system. Flywheels or other masses attached to the output shaft accentuate the deceleration-locking effect; in other words, the inertia of the flywheel, instead of adding to the total inertia of the system, reduces its effective value almost to zero during deceleration of the input.

It is stated that any standard thread or screw thread, or any type of shallow-profile thread may be used. This feature makes it possible to produce the worms with standard machine-shop equipment, although a gear-milling machine may be best when high accuracy is required. By connecting such a drive to a servo-motor, overshoot can be completely prevented because, as soon as the servo-motor stops, the drive will lock. Such a drive can thus replace conventional clutch-and-brake servos, other possible applications including drill presses, contour-milling machines, and dental drills; in short, the drive is useful wherever it is desirable to bring the tool to a sudden halt when the driving force stops.

From *Product Engineering*, U.S.A., January 18, 1960, pp. 39–43.

● *THERMAL EXPANSION OF ELASTOMERS IN SEALS*

The unusual behaviour of elastometers used in seals exposed to extreme temperatures is attributed to dimensional changes of the elastometers concerned. Although such seals often operate satisfactorily at temperatures in excess of the recommended range, they fail when the temperature is lowered; furthermore, certain seal designs fail to perform at low temperatures (−40°F), despite the fact that the materials are still flexible at temperatures as low as −65°F. The development of improved seals must therefore rest on a knowledge of the precise coefficient of linear thermal expansion and, while these coefficients are available for pure gum stock, they are not really known in the case of typical compounds used in reinforced seals and gaskets. In fact, the coefficients reported often greatly exceed the normal value, owing to the erroneous inclusion of mould shrinkage.

For these reasons, tests were recently conducted to provide much needed additional data, these data being obtained with the use of a jig made of Invar, because this material has a low coefficient of thermal expansion. A keyway of the same cross-section as the seal material was machined in this jig, and the free end of the elastomer strip was placed in the keyway opposite a scale-mark, with the other end of the strip held in position by a pin through both the strip and the keyway. The assembly was then placed in a chamber at −40°F for 24 hr, after which the length of the strip was read from the scale, and this procedure was repeated at −65°F and at −100°F. The test jig was then returned to room temperature and the strip length checked for permanent change. The same procedure was followed for +200, +300 and +400°F. As a result of this investigation, it can be stated that most elastomers expand and contract at a rate slightly more than ten times that of steel.

From *Machine Design*, U.S.A., January 7, 1960, p. 144.

● *EFFECT OF TURBINE-FUEL CHARACTERISTICS ON FLAME RADIATION*

Studies of the effect of fuel variables on the radiation from flames in a turbo-jet combustor have brought to light a number of significant facts. Thus, it has been found that the composition and physical properties of aircraft gas-turbine fuels greatly influence the amount of radiant energy emanating from the combustion

more

for less... with the MULTIMINOR

Designed to offer the widest possible range of accurate and reliable measurements at the lowest possible price, the versatility and usefulness of the Multiminor are now further extended by specially designed leads. These new leads, available at no extra cost, will accept crocodile clips or PRODCLIPS.

The Multiminor takes full advantage of the possibilities of printed circuit techniques to achieve outstanding compactness and economy of weight. The scale is clear and open. The fine red coloured pointer and effectively damped movement facilitates easy and rapid reading.

For use in Radio, TV., Electronics, Motor Vehicles, domestic appliances, workshop equipment, you'll find the Multiminor a great little meter!

Use PRODCLIPS (*Pat. No. 748811*) **with the Multiminor**

These cleverly designed spring-loaded insulated prods are the complete answer to a long-standing problem. Press the trigger to open, release to grip. Keep your hands free no matter how difficult of access your test points may be!

15/- *per pair.*

19 Ranges

D.C. Voltage	A.C. Voltage
0— 100mV.	0— 10 V.
0— 2.5 V.	0— 25 V.
0— 10 V.	0— 100 V.
0— 25 V.	0— 250 V.
0— 100 V.	0— 1000 V.
0— 250 V.	**D.C. Current**
0— 1000 V.	0— 100μA
	0— 1mA
Resistance	0— 10mA
0—20,000Ω	0— 100mA
0—2MΩ	0— 1A

List price: **£9: 10s.** *complete with Test leads, and Crocodile Clips. Leather Case if required* **39/-**

Size: 5⅝ × 3⅝ × 1⅜.

Weight: 1 lb. approx.

AVO Reg'd. Trade Mark

MULTIMINOR

FITS THE POCKET **FILLS THE BILL**

Write now for illustrated literature to:—

AVOCET HOUSE · 92-96 VAUXHALL BRIDGE ROAD · LONDON · S.W.1

VICtoria 3404 (12 lines)

AVO LTD.

A MEMBER OF THE METAL INDUSTRIES GROUP OF COMPANIES

MM12

flame and that this energy, in turn, has a considerable effect on the temperature of "hot parts" of the engine and consequently on its service life. Aromatic and naphthenic compounds were found to degrade the performance of turbine fuels as regards flame-radiation tendencies; aromatics are more deleterious than naphthenes, and the presence of one amplifies the effects of the other. Paraffinic fuels are reported to provide the best performance with respect to flame radiation, while fuels with a lower boiling range may materially reduce flame radiation in some types of gas-turbine combustors.

Of the various methods studied for correlating the physical properties of fuels with flame-tube temperatures, the use of relatively simple functions of refractive index and density was considered to be quite promising. It is stated, however, that the study undertaken was not exhaustive, and that it is therefore possible that further research will produce simpler functions and perhaps more precise correlations.

It has also been established that a lamp-type apparatus equipped with a radiation detector offers considerable promise as a simple means of predicting the radiation properties of jet fuels. About thirty fuels were tested, including wide-cut turbine fuels, kerosenes typical of current production, aromatic fuels and blends, commercial-grade hydrocarbons, and paraffinic fractions. Combustor tests were conducted in a 4-in. diameter laboratory combustor and also in two modern full-scale combustors.

From *SAE Journal*, U.S.A.,
November 1959, p. 84.

● *PROPERTIES OF ORIENTED GRAPHITE OR PYROGRAPHITE*

A special polycrystalline form of graphite, known as pyrographite, is now receiving increased attention in view of its value as a high-temperature material and its interesting physical characteristic of possessing different thermal and electrical properties along different axes. Owing to the internal structure of this material, its thermal conductivity is 500 times greater along one plane than along another, and its electrical conductivity is higher by several magnitudes in a plane parallel to the surface than at right angles to it. Compared with ordinary graphite, its electrical resistivity is far greater across the layers and considerably less along the layer plane. In one process developed for its commercial production, pyrographite is made from a hydrocarbon gas and deposited molecule by molecule on a substrate, with controlled crystal orientation. Pieces composed entirely of oriented graphite can be made by deposition on the inner surface of a mandrel, which is then cracked apart and separated from the workpiece.

A highly significant property of pyrographite is its high density, which can be as much as 2·22, and which is reported to increase with the temperature of preparation, owing to a higher degree of crystallite orientation at higher temperatures. In tests conducted in highly erosive atmospheres, the oriented graphite has shown little erosion, whereas ordinary graphite breaks down almost completely. This property is attributed to the high degree of order in the crystal lattice. Of particular interest in connection with nuclear reactors is the impermeability of the material to gases, films of from 0·001 to 0·002 in. in thickness being impermeable, even after heating to 2500°C and recooling. In view of the thermoelectric properties of this material, it may well prove suitable for electrical heating and cooling.

From *Electronics*, U.S.A.,
December 4, 1959, pp. 124, 126, 127.

● *MANUFACTURING PROCESS FOR METAL-CERAMIC MATERIALS*

A recently patented process is concerned with metal-ceramic materials which are especially useful for bearings, sealing rings, and other anti-friction purposes, but which may also be used to advantage for electrical contacts and high-temperature applications in general. At high temperatures, ordinary metallic bearings, cast or sintered, tend to seize, because the rubbing surfaces weld to each other at places where the stress is large and where the temperature is high as the result of such local contact and the relative movement of the surfaces. In the case of roller bearings, the high local pressures caused by the rollers produce indentation of the counterface, which has been softened by the high temperature, so that the bearing soon ceases to run smoothly. For sealing rings for rotating parts in pumps, etc., carbon or carbon-containing dispersed metals are at present frequently used. However, such materials are not generally satisfactory at working temperatures above about 400 to 500°C under oxidizing conditions, owing to oxidation of the carbon.

The primary object of the new process is to produce a material which will be particularly useful for bearings and sealing rings because of its improved immunity from seizure at high temperatures. This object is achieved by means of a material made from a sintered mixture of a fine metal powder of high melting point and a fine powder of a ceramic material with a melting point above 1000°C and a hardness which is less than that of corundum. The particle size of each powdered constituent is so chosen that all or practically all particles will pass through a screen of 300 mesh or even finer. The preferred metal is nickel, although cobalt, iron, chromium, copper, or mixtures or alloys of two or more of these metals can be used. The preferred

STRATELINE SPEED REDUCERS

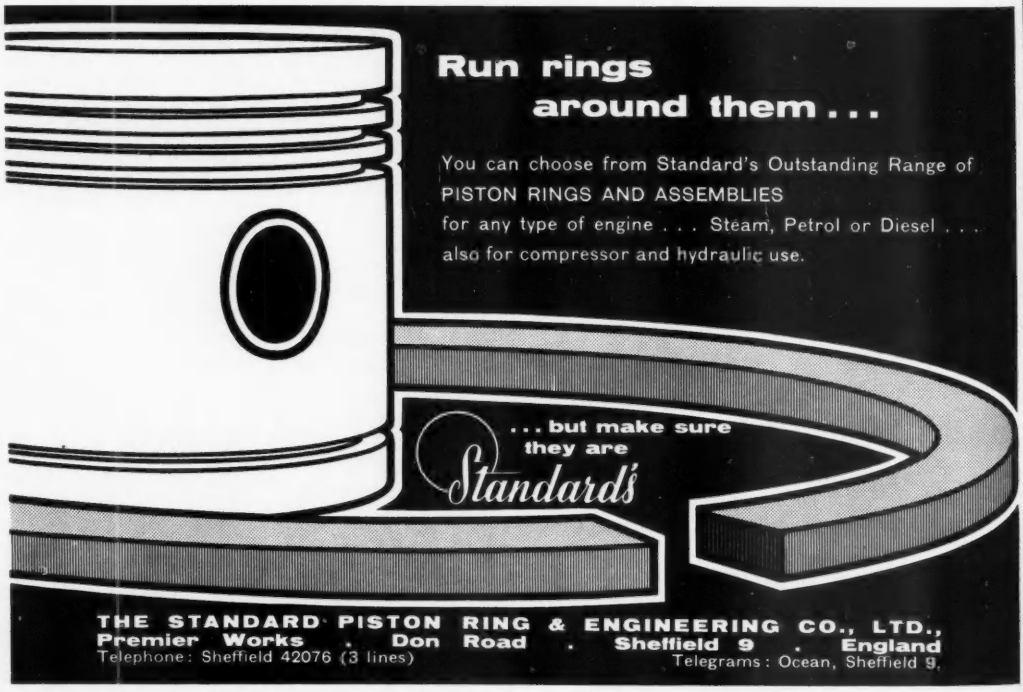
- This Strateline unit has an output capacity of 7,000 lb. in. required by maximum out of balance conditions whilst working on the Engine.
- The ratio illustrated is 60:1, but ratios between 20:1 and 100:1 are provided by the hypocycloidal gearing.
- Self-sustaining Strateline mechanism which operates when movement of input handle ceases—the engine can be rotated, and sustained at any position, through 360°.

The photograph above shows the type CW1 Strateline unit fitted to a Rolls-Royce Dart Aero Engine Overhaul Stand designed and manufactured by Messrs. Morfax Limited of Mitcham, Surrey. The high efficiency and compact assembly of the Strateline makes it particularly suitable for manual operation and many variations have been supplied for high pressure valve operation, hand winch units, furnace tilting, etc. Where reasonable quantities are involved we are prepared to design special units against particular applications

VARATIO-STRATELINE GEARS LTD.

277/9 ABERDEEN AVENUE,

TRADING ESTATE, SLOUGH, BUCKS.


Run rings
around them . . .
You can choose from Standard's Outstanding Range of
PISTON RINGS AND ASSEMBLIES
for any type of engine . . . Steam, Petrol or Diesel . . .
also for compressor and hydraulic use.
. . . but make sure
they are
Standard's
THE STANDARD PISTON RING & ENGINEERING CO., LTD.,
Premier Works . Don Road . Sheffield 9 . England
Telephone: Sheffield 42076 (3 lines)
Telegrams: Ocean, Sheffield 9.

ceramic material is mullite ($3Al_2O_3.2SiO_2$). The relative proportions of the constituents of the sintered mixture can be varied within wide limits. Thus, the metal constituent can be from 50 to 90% by weight of the mixture, though the preferred content is about 75%. Conventional ceramic techniques can be employed for forming bearings, e.g., slip-casting or plastic extrusion, but the recommended procedure is to press the mixture in the dry powdered state with a temporary agent such as wax.

From *Brit. Pat. Spec.* 824,124,
The Morgan Crucible Co. Ltd., London, England.

● ***GAS-SHIELDED METAL-ARC WELDING PROCESS FOR STEEL***

Characterized by the use of a special wire electrode and the use of a gaseous mixture of carbon dioxide, a recently patented Japanese gas-shielded metal-arc welding process has been developed for the production in steel of high-quality welds which combine adequate strength with a minimum of blow-holes, very low hydrogen content, and superior mechanical properties readily controllable within limits. In addition, the process improves the appearance of the beads and eliminates cracks in the weld metal and the metal in the zone affected by the welding heat.

The new wire electrode is of iron or steel containing from 0·7 to 5% manganese, 0·25 to 5% silicon, and titanium up to 5% as deoxidizers. It has been found that, if the wire electrode does not contain sufficient deoxidizer, numerous blow-holes appear in the welds, even if welding is performed under a shield of carbon dioxide and oxygen. On the other hand, when the electrode wire contains a sufficient amount of deoxidizer, dense welds, free from blow-holes, can be produced. The mixture of carbon dioxide and oxygen contains from 11 to 5% by volume of oxygen. In this connection, it has been found that, if the shielding gas comprises carbon dioxide only, the strength and hardness of the welds are too high, while ductility is reduced. With a mixture of carbon dioxide and oxygen, however, the welds obtained are not only free from blow-holes, but also have a very low hydrogen content, with adequate strength and hardness and high ductility. Moreover, these mechanical properties can be controlled within certain limits by suitable adjustment of the oxygen content of the mixture. It should be noted that the addition of more than 11% by volume of oxygen to the shielding-gas mixture facilitates removal of the thin slag formed over the beads and also permits deeper penetration. However, if the oxygen content is higher than 50%, porous welds result.

Aluminium, calcium, magnesium, zirconium, and other elements can also be incorporated in the steel electrode wire as additional deoxidizers. Also, the wire can contain various alloying elements, including chromium, vanadium, and molybdenum, for improving the properties of the welds.

From *Brit. Pat. Spec. No.* 824,038,
Harujiro Sekiguchi, Aichiken, Japan.

● ***AGE-HARDENING TITANIUM ALLOY***

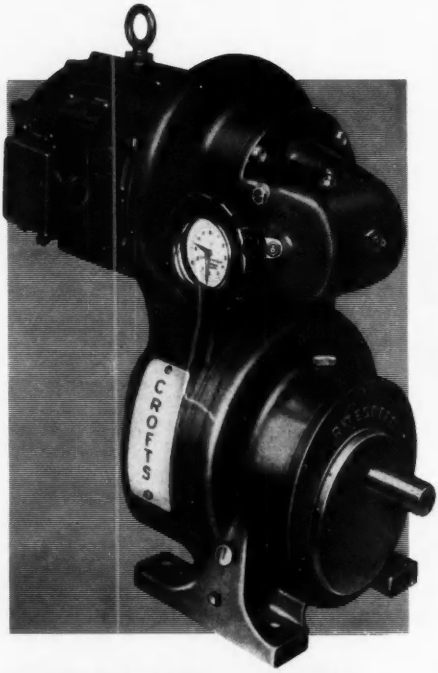
A new beta-titanium alloy has been developed which is claimed to have the highest strength and best formability of any titanium-base alloy developed so far. In fact, it is considered to be as far superior to commercial-grade titanium as 18-8 austenitic stainless steel is to plain carbon steel. With a nominal content of 13% V, 11% Cr, and 3% Al, the structure is 100% beta. As in the case of austenitic steel, the high-temperature crystalline form is preserved down to room temperature, and this is of particular advantage in the case of titanium, because the beta phase possesses excellent formability and can be aged to high strength values at a conveniently low temperature.

The aluminium content, which normally is an alpha-stabilizer, serves a number of purposes. Thus, it makes the use of vanadium commercially possible, because alumino-thermic vanadium consisting of 85% V and 15% Al can be used. At low temperature, ageing embrittlement decreases when small amounts of aluminium are present. Aluminium also causes additional solid-solution strengthening, improves oxidation resistance, and promotes alpha-phase formation during ageing above 600°F, thus serving to increase the strength of the aged product with less increase in transition temperature than would be caused by most alpha-stabilizers. Since formability in the solution-treated condition decreases with increasing aluminium content, its limitation to 3% appears to be the best compromise.

The new alloy, having been developed for use in the form of sheet, naturally attains its best properties in this form. Thin sections are believed to have better properties than heavy sections, because they undergo a greater amount of cold-working and consequently possess greater structural refinement.

From *Metal Progress*, U.S.A.,
December 1959, pp. 119–122.

Readers desiring further information on any developments reported in THE BLUE PAGES are invited to write to the Editor. Copies of the full specifications of any British patents mentioned, which are published by courtesy of H.M. Stationery Office, should be obtained from the Patent Office, 25 Southampton Buildings, Chancery Lane, London, W.C.2. Price 3s. 6d. each.



On Call

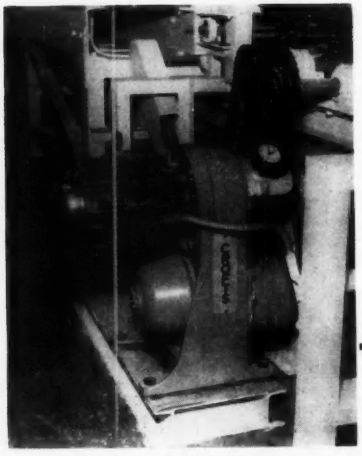
IN EVERY INDUSTRY

CROFTS VARIABLE SPEED MOTOR GEARS

- Clean, safe, and totally enclosed.
- Electric motor, variable speed drive and 'Ritespeed' reduction gear, all in one compact unit.
- Self-locking device prevents accidental alteration of speed.
- Remote or automatic control to order.
- Drives in either direction.
- Universal and Vertical types, also Universal Flange-Mounting types with horizontal or vertical shafts.

Five Standard Sizes, from ¼ H.P. to 10 H.P., available FROM STOCK.
Larger sizes available, up to 20 H.P.
Ratios from 2:1 to 10:1.

Ratios may be increased by fitting 'Hiratio' adaptor



A Vertical Unit in use on cereal processing machinery (Guards removed for clarity)

Post this coupon Today!

CROFTS (ENGINEERS) LIMITED
POWER TRANSMISSION ENGINEERS

THORNBURY BRADFORD 3 YORKSHIRE
Telephone: 65251 (20 lines)
Telegrams: "Crofters Bradford Telex" Telex 51186
REPRESENTATION THROUGHOUT THE WORLD

Crofts
REGD. TRADE MARK

☐ Variable Speed Motor Gears *Publication 5739A*

Literature also available on:

☐ Variable Speed Gears *Publication 253A*
☐ C-JR Vary-speed Controls *Publication 453AB*
☐ 'Multispeed' Geared Motor Units and Reduction Gears. *Publication 592I*
☐ Variable Speed Pulley Drives. *Publication 353AB*

Please indicate items required.
Name & Address .....
.....
..... *ED*

THE ENGINEERS' DIGEST

A World Review of DESIGN & PRODUCTION—RESEARCH & DEVELOPMENT

VOL. XXI No. 2 FEBRUARY, 1960

Titanium-Platinum Electrodes for Cathodic Protection in Sea-Water

By G. BOMBARA and D. GHERARDI

From *La Matallurgia Italiana*, Italy,
Vol. 51, No. 10, October 1959,
pp. 462–465, 7 illustrations

EXTENSIVE use is being made of platinum-faced titanium as a sacrificial-anode material for cathodic protection in sea-water or in other solutions containing chlorides without, however, having detailed knowledge of its electrochemical behaviour. For this reason, an investigation has been carried out in order to obtain full data on the anodic properties (weight losses and potentials as functions of current density) of titanium and platinum anodes, separately and in pairs, and also of titanium-platinum bimetal anodes and platinum-plated titanium anodes.

The corrosion resistance of titanium to various media can be attributed to the exceptionally stable film of oxide which is spontaneously formed on this metal, and which provides passive protection under certain conditions. In the electrochemical series, where metallic materials in sea-water are concerned, titanium is in the same class as such metals as Inconel (which gives complete passivity), monel metal, and the stainless steels. There is, indeed, considerable analogy between titanium and stainless steels in their general behaviour as regards corrosion and the mechanism of passivity.

Insofar as its use as an anodic material in sea-water is concerned, titanium is definitely superior to the stainless steels, and also to monel metal and nickel, owing to its notable resistance not only to chlorides, even at high temperatures, but also to hypochlorites.

Materials and Test Conditions

Specimens of pure titanium, made from sheet of 1 mm thickness, were first roughened with emery paper in the dry condition, and then dipped in CH_3COOH (5%) for 5 min and in H_2O_2 (10%) for 1 min, the purpose of this treatment being to enable the passivating film to be formed rapidly. The test specimens were then washed in water, dried with alcohol, and passed through ether before weighing. For the platinum electrodes, which were also employed either separately or in combination with the titanium electrodes, chemically pure platinum was used, with the same dimensions and treatment as for the titanium specimens.

All tests were carried out at ambient temperature in sea-water synthetically prepared in the laboratory, with a ratio of volume of solution to exposed surface area of 700 cc/cm², i.e., a considerably higher ratio than the value of 50 cc/cm² normally recommended as a minimum for corrosion tests. Each specimen was fitted to the bottom end of a rod placed in the centre of a test cell, 10 cm in diameter, which had four graphite cathodes arranged around its periphery.

For measurements of potential, a standard calomel electrode was used as a reference, with a capillary probe located at a distance of 1 mm from the level of the specimen, as shown in Fig. 1. In all the tests, the solution was stirred electromagnetically.

Behaviour of Titanium

The protective property of the oxide film on titanium is clearly established by extremely high values of anodic polarization, the magnitude of which is determined by the high ohmic resistance of the protective layer. With a current density of 1000 A/m², the value of polarization is 2 V for platinum, and 20 V for titanium.

The phenomenon of primary interest, which limits the useful range of current densities, is the breakdown of

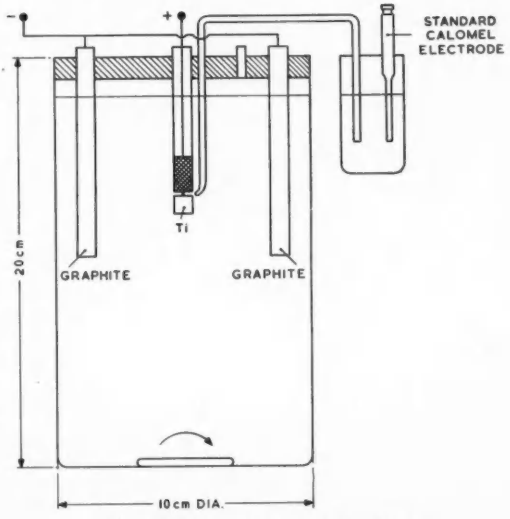


Fig. 1. Cell for cathodic-protection tests.

the oxide film, which occurs, under the conditions tested, between 200 and 400 A/m². This breakdown occurs suddenly, after a rise of the polarization-potential curve towards a peak value, with an uncontrollable oscillatory instability of potential, followed by a drop from the maximum polarization of 22 to 23 V to a value of 19·5 V, which thereafter remains constant with a further increase in current density.

The rate of attack of titanium, as a function of current density, i.e., the weight loss per unit area per hour, was also determined, measurements being taken at hourly intervals. It was found that, in the critical region of current densities, the attack increased hyperbolically and was localized in areas which probably correspond to the points of initial breakdown of the oxide film. Pronounced attack generally occurred at positions which were the most critical from the point of view of the passivating film, such as edges, angles, etc.

Pairs of Titanium and Platinum Anodes

Curves of anodic polarization were determined for two pairs of titanium and platinum electrodes, with area ratios of 1:1 and 20:1 respectively. These electrodes, mounted on rods, were placed at a suitable distance apart in the test cell, and each was provided with a capillary and separate standard calomel electrode. For each value of total anodic current, the distribution of current between the platinum and titanium electrodes was measured, enabling the current densities of each of these electrodes to be plotted as functions of the common polarization potential.

As expected from the polarization curves of the individual metals, the current is conducted mainly by the platinum for potentials below that of the breakdown of titanium. Conduction of current of the same order as that of the platinum occurs through the titanium only after breakdown of the titanium, when its critical anode potential has been exceeded, with correspondingly higher weight losses.

Titanium-Platinum Bimetal Anodes

Small discs of platinum were brazed to both faces of the titanium strips, an area ratio of 1:6 relative to the titanium being used. The polarization potentials and the rate of attack of these bimetal specimens were then determined as functions of current density.

In accordance with the previous findings, an enormous reduction in anodic polarization was obtained, with a displacement of the breakdown region from 200 to 400 A/m² for titanium by itself up to values of the order of 6000 to 7000 A/m² for the bimetal specimens.

The increase in the rate of attack, again determined by measurements at hourly intervals, was fully in agreement with the polarization curve. The loss of anodic material is approximately zero up to 50 A/m², and remains very small up to current densities only just below the critical value. The presence of platinum with the area ratio used therefore extends the range of application of the titanium anodes up to 5000 A/m². The attack on the titanium was mainly confined to the edges, particularly since these were the points furthest away from the platinum.

Platinum-Plated Titanium Anodes

Specimens of titanium of the same dimensions as in the previous tests were subjected to a cathodic cleaning treatment at high current density in aqua regia, and were then electroplated with platinum in a solution of chloroplatinic acid at 90 to 95°C, using a current density of 0·6 A/cm². The thickness of the platinum layers thus obtained was of the order of 2·5 microns.

The polarization curve for electrodes with this platinum layer was found to coincide practically with that of pure platinum up to 3000 A/m², but, beyond this current density, it showed a definite rise above the curve for platinum. A specimen was then subjected to an anodic current of 3000 A/m² for 16 hr in sea-water, without any loss in weight. In a further test, another specimen was subjected to 1500 A/m² for 100 hr, and also showed no weight loss.

Long-duration tests were also carried out, using platinum-plated titanium electrodes with an exposed area of 1·3 cm² as anodes in sea-water in the cells used for the previous tests. The solution was renewed at 7-day intervals, and the tests were made with various plating thicknesses of platinum, using two different current densities of values definitely higher than that required for titanium breakdown. It was found that all the specimens had a limited useful life. Thus, after a certain period which is a function of layer thickness and current density, the platinum plate began to break down at some points, leaving the titanium exposed over increasingly large areas. After some further period, violent disintegration of the titanium occurred.

The end of useful life is first indicated by a noticeable increase in polarization potential (which remains stable up to this moment), because titanium enters into the process. The tests gave useful life values of 85 to 100 hr for layers 0·2 micron thick at 1400 A/m², and 850 hr for 2·5-micron layers at the same current density. At 2300 A/m², values of about 350 hr were obtained for a layer thickness of 2·5 microns, 250 hr for 1·75 microns, and 2 hr for 0·2 micron.

The limited life of the platinum plating on titanium is due to the fact that platinum in a chloride solution is subject to attack (although at a fairly low rate) at high anodic-current densities such as those used in these tests. Pure platinum specimens of the same shape and dimensions as the titanium specimens were tested, the weight losses at 2300 A/m² being zero after 200 hr, 0·092 mg/cm² after 500 hr, 0·35 mg/cm² after 1000 hr, and 0·67 mg/cm² after 1800 hr.

The losses after 1000 hr of operation are therefore of the same order as the weight of platinum present on an area of 1 cm² of platinum-plated titanium, with a plating thickness of 0·2 micron. Moreover, account must be taken of the non-uniform consumption of anodic material in different areas, and imperfect adhesion of the plated coating on some parts of the titanium base.

The remarkable anodic properties of titanium and particularly platinum-plated titanium can be appreciated by comparison with corresponding figures for graphite used as an anode, which shows losses of the order of 15 mg/cm² in sea-water at current densities hardly reaching 80 A/m² after less than 50 hr of exposure, whereas platinum-plated titanium with a layer thickness of even less than 0·2 micron suffers no loss in weight over the same period, even at current densities of 1400 A/m².

Thus, platinum-coated titanium seems particularly suitable for use as an anode material for cathodic protection in sea-water. In fact, the addition of platinum gives an anodic protection which is up to ten times greater than that obtainable with titanium alone, its durability depending to some extent on the adhesion of the platinum plating and hence on the type of plating process used.

By P. HOEKSTRA and C. MEYER
and
J. J. KOTTE

From *Philips Technical Review*, Holland,
Vol. 21, No. 3, 1959/60,
pp. 73–87, 19 illustrations

Improved Pulsed-Light Source and Motion-Picture Projector

In this article, Hoekstra and Meyer discuss an improved illumination system for motion-picture projection which uses as the light source a super-high-pressure mercury-vapour lamp operated by current pulses, thereby dispensing with the need for a shutter, and which incorporates a number of interesting features to make it practical and convenient to use in cinema theatres. In addition, details are given by Kotte of a motion-picture projector of radically simplified design, which can be used in conjunction with the pulsed-light source or with the more conventional carbon arc.

CONVENTIONAL carbon arcs as light sources for motion-picture projection have certain inherent disadvantages, notably in connection with the heat they produce and the tendency of the arc crater to shift. It is not surprising, therefore, that attempts have been made to find alternative light sources with a comparable intensity of illumination. Indeed, as long ago as 1938, Philips introduced a water-cooled super-high-pressure mercury-vapour lamp rated at 500 V, 2 A d.c., for this purpose.

Compared with carbon arcs, discharge lamps of this kind do not produce unwanted deposits, thus dispensing with the need for an exhaust system, and heat the film far less than a carbon arc with the same luminous flux, mainly because they produce considerably less infra-red radiation. In addition, a smaller lamp-house can be used. It is true that water-cooling is required, but this complication is more than offset by the advantages obtained and, in any case, the use of high-current carbon arcs often calls for water-cooling of the film gate and sometimes also of the positive-carbon contact.

At the same time, it should be noted that the discharge lamp lends itself well to synchronous pulsing, with a view to eliminating the need for a shutter. In conventional illuminating systems, the light is interrupted by the shutter twice during each frame period, i.e., once when changing from one frame to the next, and once during exposure of the frame on the screen, so as to decrease the tendency to flicker. With a pulsed-light source, in which the lamp is loaded only when its light is usefully employed, the instantaneous load can be raised, while maintaining the same mean load, providing more useful light and better colour rendering, owing to its changed spectral distribution.

Here again, it should be noted that the pulsed-light technique is by no means new; in fact, such a system was used in 1938 with the mercury-vapour discharge lamp already mentioned. The fact that this lamp, in its first attempts to rival the carbon arc, was unsuccessful was mainly due to the deficiencies existing at that time with respect to its luminous flux, its rendering of red colours, and its reliability. Also, the tests with the pulsed lamp were initially disappointing, as its life was found to decrease sharply when the instantaneous load was increased, even though the mean load remained unchanged.

The New Pulsed-Light System

The new pulsed-light system essentially comprises an improved design of super-high-pressure mercury-vapour discharge lamp and lampholder, a special optical system, and the power-pack for supplying the current pulses, with its associated synchronization equipment.

The Lamp and Lamp-Holder

The new version of the lamp may be said to represent a compromise between useful life and light output (as determined by the mean load) and colour rendering (as determined by the peak amptitude of the current pulses). As a result, the new lamp has a mean load of 800 W, with current pulses of about 15 A peak amplitude, the mean life under these conditions being 33 hr. The luminous flux incident on the screen is equal to that of a 60-A carbon arc and is therefore adequate for most cinemas, while the colour rendering is also entirely satisfactory.

Basically, the new lamp consists of a small tube of fused silica, in which a linear discharge of mercury vapour is maintained between two electrodes. In this connection, it must be mentioned that the 1000-W lamp used in the 1938 projector was of the type containing a surplus of mercury, i.e., only a small amount was vaporized when the lamp was burning. However, this lamp possessed certain disadvantages, notably with regard to unsteady operation and the need to shake or tap the lamp before ignition to ensure uniform distribution of the mercury around the electrodes. It was therefore decided to develop a dosed lamp, i.e., a lamp containing so little mercury that practically all is vaporized during operation, and particularly with a view to its use for pulsed operation.

It should be appreciated that a dosed lamp cannot be made merely by taking a lamp that is identical with the old surplus-mercury type and providing it with a dosed amount of mercury, as the electrodes would then project too far into the discharge space, and the mercury-vapour pressure would not attain the high value required. To produce a dosed lamp in which the vapour pressure rises to the same high value as in a surplus-mercury type, the end-wall must be located at approximately the position taken up by the mercury surfaces in the surplus-type lamp. This, however, represents a problem:—In the surplus-type lamp, the electrodes are tungsten wires and, as these cannot be sealed directly into fused silica, they are first sealed into an intermediate glass which, in turn, is sealed to the silica. However, this form of intermediate seal is not suitable for use in the dosed lamp, because the spaces behind the ends of the electrodes cannot be made small enough, and the intermediate glass seal cannot withstand the necessary high temperature. For this reason, a molybdenum-foil seal was adopted, thereby eliminating the need for an intermediate glass. Very thin foils of molyb-

denum can quite readily be sealed in silica, the foils used being from 10 to 12 microns thick. The lead-in wire is welded to one end of the foil and the tungsten wire electrode to the other. However, a foil seal is itself too weak to secure an electrode with sufficient mechanical strength. On each electrode wire, therefore, is a closely fitting capillary of fused silica, the whole electrode assemblies then being introduced into the fused-silica lamp tube and sealed in.

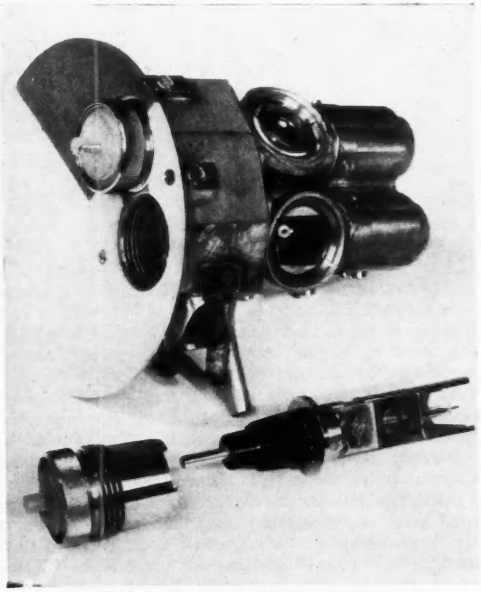


Fig. 1. Lamp-turret with two lamp-holders.

It was also necessary to ensure that the temperature developed in the gaps round the electrodes is not below that of the wall near the discharge. With this in mind, the diameters of the electrode wires are chosen in such a way that the lamp current generates the right amount of heat in the wires for this purpose. Another problem is the dissipation of heat:—In the surplus-type lamp, the mercury around the electrodes is responsible for considerable heat dissipation by conduction, whereas, in the dosed lamp, the heat must be dissipated mainly by radiation. Each of the electrodes is therefore fitted at the end with a head to obtain a sufficiently large heat-radiating surface. The edges of the electrode heads are so close to the wall of the lamp that it is necessary to widen the bulb slightly at this position; otherwise, the bulb temperature would become so high as to cause rapid devitrification of the silica.

Special attention has been paid to the design of the twin lamp-holder and its associated turret for rapid change-over from one lamp to another. The components of the lamp-holder are so made that they mate together correctly without any adjustments during assembly. A round glass window in front of the lamp serves as a filter which absorbs ultraviolet radiation. The cooling water flowing over the lamp also passes over the filter, thus dissipating the heat generated there. Of the little infra-red radiation emitted by the lamp, the major part is absorbed by the coolant, so that heating of the film and film gate is slight.

Fig. 1 shows how the two lamp-holders are fitted into the lamp-turret. The lower holder, shown removed from the turret, contains the lamp normally in use, while the upper holder contains the stand-by lamp. If the lamp in the lower holder becomes defective, the upper lamp automatically takes its place, the lamp turret pivoting about a horizontal spindle under its own weight. This is effected by the lower lamp being kept in its operating position by a pawl which is tripped when the lamp current cuts out. The cooling water flows in along the spindle around which the lamp-turret rotates, and reaches the operative lamp-holder via corresponding holes in the spindle and turret. The cooling water is thus automatically switched to the stand-by lamp as soon as this is brought into operation, as also is the electric supply. The stand-by lamp takes over so quickly as to be imperceptible to the audience, but the projectionist notices the change-over from the colour of a transparent sector on the front of the turret. If the projector is operating normally, a green sector is visible; when the stand-by lamp enters into operation, a red sector appears as a warning to the projectionist, who can now unscrew the lower lamp-holder from the turret and replace the lamp whilst the projector remains in operation. Later, when there is a suitable opportunity, he can turn the lamp-turret by hand back to its normal position.

When a lamp-holder and its lamp are loaded into the turret, the exposed end of the lamp slides into a hole surrounded by an annular nozzle inside the turret. The electrode pin at this end then presses against a spring-loaded contact, which also acts as a valve, shutting off the water supply to the nozzle when no lamp is mounted. The other lamp electrode pin is clamped inside the contact peg at the head of the lamp-holder. When the lamp-holder is in the operating position, this peg lies on a contact consisting of a metal flat partly encapsulated in a block of insulating material, this block being fixed to the lamp-house in which the lamp-turret is incorporated.

The Optical System

In the optical system used (Fig. 2), the film (8) and the aperture (7) are located directly in front of the condensers (5) and (6), the effective diameter of the condenser system being only slightly larger than the diameter of a film frame. As a result, the light source must be close to the condenser, providing a very compact assembly (Fig. 3). Condenser (5) also serves as a water-tight window for the lamp-turret.

Behind the light source (2) is a cylindrical reflector (1) made of aluminium sheet, 0·3 mm in thickness, which provides more than 60% of the reflected light. The condenser system is so arranged as to project an image (10) of the light source (2), as shown in Fig. 2, the optical centre of the condenser falling virtually on the film and hence at the focal point of the projection lens (9).

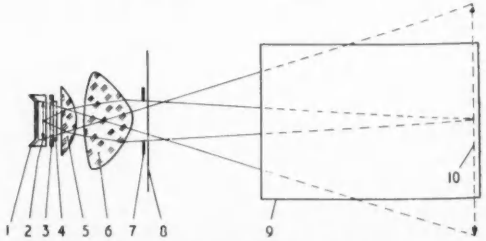


Fig. 2. Schematic arrangement of the optical system.

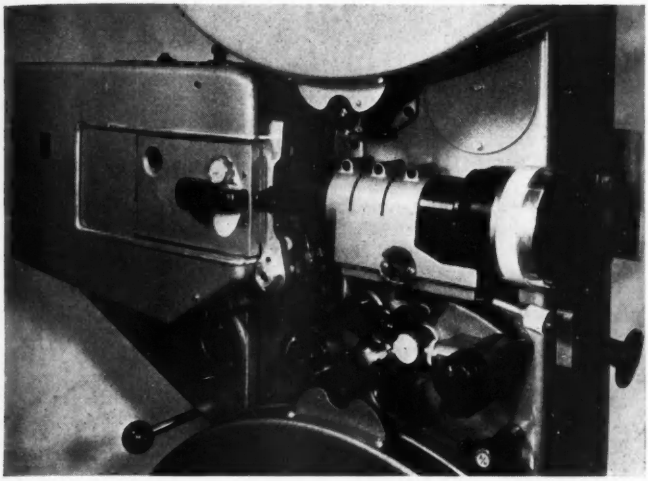


Fig. 3. Part of a motion-picture projector fitted with the pulsed-light source, showing the compactness of the optical system and lamp-house.

To avoid needless heating of the condenser and film gate, a diaphragm (3) is interposed between the lamp (2) and the condenser (5). This diaphragm, which is matched to the projection lens, intercepts the unused light and also serves as a holder for the ultraviolet filter (4).

The same illumination system is used for the projection of lantern slides, the slide-holder being located at the other side of the projector. In operation, the lamp-house is pulled backwards, causing a plane mirror to move into the path of the rays at an angle of 45 deg., the light then reaching the lantern slide via a lens, another 45-deg. mirror, and a second lens.

Current-Pulse and Synchronizing Equipment

A simplified block diagram of the power-supply system for providing current pulses to the lamp is shown in Fig. 4. A six-phase rectifier (1) charges the capacitor (2) to a voltage which is higher than that of the lamp (6) and, at the moment when the lamp is required to flash, a voltage pulse is applied to the grid of the thyratron (3), making it conduct. The capacitor (2) then discharges through the lamp (6), and the inductance (4) tends to produce an oscillation in the circuit. However, at the moment that the current attempts to change direction, the thyratron (3) becomes non-conductive, and the lamp (6) is extinguished, after which the rectifier (1) again charges the capacitor (2) and, with the next voltage pulse on the grid of thyratron (3), the lamp flashes again. At the same time, the lamp is fed by a " holding-current " rectifier (5), which ensures that a small current continues to flow through the lamp in the period between successive flashes, thereby keeping the mercury vapour sufficiently ionized to cause it to flash readily on arrival of the next current pulse. The duration of the flash depends on the period of oscillation produced in the circuit, and this period can be adjusted by varying the inductance (4) or the capacitance (2), or both.

The rectifier (1) operates with six thyratrons, and the voltage it delivers can be adjusted by means of a variable bias on the grids of these thyratrons, making it possible to control the amplitude of the current pulses. This variation is effected with a potentiometer (7), which can either be mounted on the projector or placed at any other desired position, e.g., in the cinema auditorium. Flash duration and peak current together determine the energy per flash and also (at a given number of flashes per second) the average lamp load. If this load varies from 600 to 800 W, the power pack consumes from 1·3 to 1·6 kW, whereas a comparable carbon-arc installation consumes approximately 3 kW.

To obtain a flicker-free picture, the light source is arranged to flash three times per frame, i.e., 72 flashes per second, as compared with the normal 48 per second. The sensitivity of the eye to flicker increases with the brightness of the picture, while the periphery of the retina is more sensitive to flicker than the central part. The lack of flicker in the picture from the new projector is therefore particularly noticeable in the brighter projection of wide-screen pictures.

The three light flashes per frame must, of course, occur outside the pull-down period. The synchronizing pulses for the grid of the thyratron (3) are therefore derived from the steel flywheel (11) of the Maltese-cross

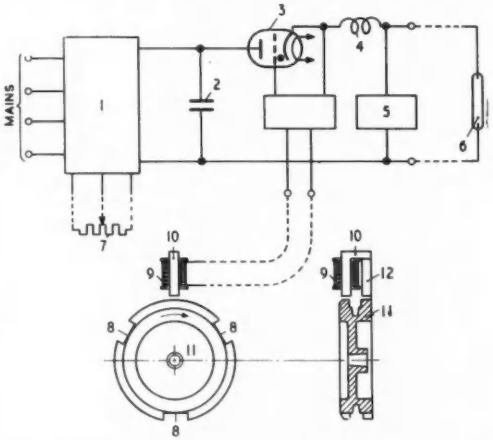


Fig. 4. Simplified block diagram of the power-supply system for providing synchronized current pulses to the lamp.

intermittent movement in the projector. This flywheel, in which three grooves (8) are milled, forms part of a magnetic circuit which includes a permanent magnet (12) and a soft-iron core (10), around which a coil (9) is wound. Every time one of the grooves passes this assembly, the magnetic flux is sharply attenuated. The resultant voltage pulse in the coil (9) is applied to the grid of thyratron (3). The exact moments at which the flashes occur can readily be adjusted by shifting the position of the magnet, core, and coil assembly in relation to the flywheel (11),

and this can be carried out whilst the projector is operating.

Precautions are taken to ensure that the lamp, in the event of a fault, cannot burn continuously directly from the rectifier (1), and also to prevent it operating only from the holding-current rectifier (5).

The lamp is also pulsed for the projection of lantern slides, in order to benefit from the improved colour rendering conferred by pulsed operation. In this case, as the projector is not running, the synchronizing pulses for the thyratron (3) are derived directly from the mains and are delivered at twice the mains frequency, i.e., 100 pulses with a mains frequency of 50 cps. To avoid overloading the lamp, the capacitor voltage is then at the same time automatically reduced in such a way that the average load remains the same.

Simplified Design of Motion-Picture Projector

Conventional motion-picture projectors are almost invariably built up from a number of sub-assemblies, each with its own function and usually fitted together on accurately machined horizontal faces. However, each sub-assembly, e.g., optical sound units and magnetic sound-track units, requires its own housing or frame and, since the path followed by the film must lie in a single vertical plane, all these sub-assemblies must be very carefully lined up—usually a lengthy and difficult operation.

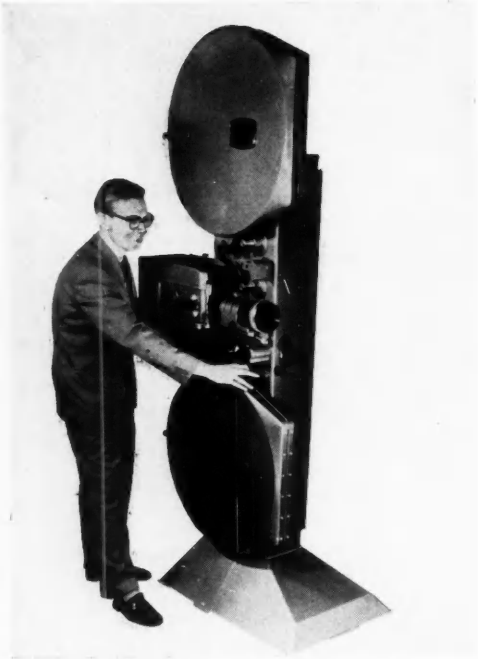


Fig. 5. The new Philips projector, fitted with 6000-ft film magazines, a pulsed-light lamp-house, and optical and magnetic sound-heads.

In a new projector developed by Philips, a different approach has been adopted, the main object being to simplify design, while still retaining flexibility, i.e., the possibility of adding or replacing components easily in accordance with requirements. This has been achieved by mounting all components concerned with the film path on a vertical panel, thus dispensing with the laborious work of lining up. For this purpose, use is made of a column of rectangular cross-section, bent and welded to shape from sheet steel, and closed at the top by a welded steel cover, so as to increase structural rigidity. The bottom of the column is open, rigidity being conferred by a base-piece. The wide side-panel on which the components are mounted is easy to bring within the specified flatness tolerances and requires no special machining.

The mounting panel contains all the necessary holes, threaded and otherwise, appropriate to the various versions of the projector. For example, magazines for 2000-ft or 6000-ft reels of film can be mounted, the bearing brackets for the reel spindles being shifted accordingly. In all versions, the projector is fitted with an optical sound-head, but, if the upper film magazine is moved up 140 mm, there is also room on the column for a magnetic sound-head. The projector can be used with the pulsed super-high-pressure mercury-vapour lamp, already discussed, in which case the lamp-house can be attached directly to the mounting panel. Alternatively, any other light source can be used, the corresponding lamp-house then being mounted on a platform screwed to the column. A typical version of the new projector, in this case fitted with 6000-ft magazines, a pulsed-light lamp-house, and optical and magnetic sound-heads, is shown in Fig. 5.

The columnar type of construction adopted also makes it possible to drive all components concerned very simply by means of silent, slow-running chains, safely accommodated and protected from dust, etc. inside the column, but readily accessible through a door in the panel of the rear wall. The use of this chain transmission also eliminates a number of the elements required in conventional projectors. Thus, for instance, in most orthodox types of projector, two helical gears, two bevel gears, and two transmission shafts are normally required to drive the lower film reel alone. Similarly, when changing over from 2000-ft to 6000-ft magazines in the new projector, all that is necessary is to shift the reel-spindle bearing brackets, as already mentioned, and to lengthen the driving chain; in conventional projectors, on the other hand, larger castings and a longer transmission shaft are required and both the film path and the transmission have to be lined up. Another advantage of the columnar type of construction is that the interior of the column forms an ideal housing for electric wiring, eliminating the need for the electrical connections between the various sub-assemblies by means of flexible cables, as in conventional projectors.

Other features of the new projector include an improved type of framing adjustment and a simplified design of fire traps. Thus, in the new framing device, rotation of the framing knob causes the intermittent sprocket to rotate relative to the Maltese-cross without, however, rotating the Maltese-cross mechanism, as in some designs. With regard to fire traps, conventional projectors usually employ a roller-type trap, closed at the front by a lid attached to the magazine, and a sprocket with two pad-rollers for ensuring that the sprocket teeth engage the film perforations properly. In the new design, the pad-rollers are replaced by a guide-shoe enveloping the sprocket over a wide angle in such a way that the shoe and sprocket together constitute an efficient fire trap,

which is also closed by a flat lid attached to the magazine. This design reduces the number of components required and the time taken to thread the film.

Finally, it should be noted that the projector is designed for remote control from the auditorium. In large cinemas, the screen is so far away from the projectors that the projectionist is often unable to focus the picture as sharply as someone nearer the screen. Provision has therefore been made for incorporating inside the column a small motor which, via reduction gears, controls the focus adjustment, the motor being operated from a control box set up inside the auditorium. Framing and sound volume can also be adjusted from this control box and, if the projector is equipped with the pulsed-source lighting system, the box can be provided with a control for regulating lamp power.

An Improved Sublimation Method of Temperature Control of Hypervelocity and Space Vehicles

by R. FELDMAN*

This article is a condensation of a monograph entitled "A New Approach to Temperature Control of Hypervelocity and Space Vehicles", and is mainly concerned with the new "Thermo-lag" sublimation or ablation process developed by the author and his research team.

IN the design of present-day high-speed missiles, it is necessary, in addition to countless other problems, to cope with those of temperature control in components and structures, in which heating may be a result of such phenomena as aerodynamic heating, propellant burning in rocket motors, or convection from high-temperature gases in rocket-motor nozzles.

One of the more publicized heating problems is that of re-entry. Re-entry vehicles undergo intense transient heating, heating rates of about 2500 BTU/sq. ft-sec being typical. Re-entry or any kind of aerodynamic heating is produced when the atmosphere is braking the speed of the vehicle. In the case of ascent, this is parasitic, whereas, in the case of descent, it is useful. The energy of the body is changed into heat, and the body-protection system must keep this heat from the interior of the body.

The kinetic energy of motion is transformed into thermal and disassociation energies of the air, and the temperature near the body may be measured above 15,000 to 20,000°F. A high temperature gradient, as well as high surface shear, promotes very high rates of heat transfer into and through the skin and into heat-sensitive equipment. Unless this heat is removed or absorbed in some medium, destruction of essential missile components may occur. A similar situation exists in rocket motors and motor nozzles, the internal surfaces of which are subjected to high temperatures and pressures.

In order to alleviate these effects, the more common practices for heat protection of missiles and space vehicles have to date included (a) insulation of the surface from high-temperature effects, where possible, (b) provision of sufficient metal thickness where insulation cannot be used, in order to compensate for metal strength lost from high temperatures and to provide a heat sink for the energy absorbed, (c) recirculation of the fuel in the thermally critical areas in cases where liquid propellants are used, (d) the use of radiation shields, (e) the use of transpiration cooling, i.e., pumping liquids or gases through external structures artificially rendered porous, and (f) the use of ablative materials, i.e., materials which sublime under heat.

Nearly all these methods have serious deficiencies, as they are either too heavy, too costly, too difficult to apply, or are subject to failure under unusual or abnormal heating conditions. Thus, for example, in the case of insulating materials, their applicability in the missile field is not as high as in the commercial field, generally because of their large weight or excessive thickness requirements, while the plumbing needed to distribute the coolant over a substantial area in the transpiration-cooling method gives rise to certain difficulties in practice and has caused delays in the adoption of this method.

The longer is the duration of a hypervelocity flight, the more attractive is the idea of cooling by radiating the heat into the surrounding space. The temperatures required to dissipate the average heat flux, e.g., those encountered during re-entry, are about 1600 to 1900°F, these being so-called equilibrium or steady-state temperatures. The concept of a radiation shield, i.e., a thin-walled insulated radiating skin, supported by insulation around the body for heat protection, is indeed a tempting one. However, unlike the heat-sink method, which is a system operating below the melting point of the heat-absorbing material and in which the rate of heating is of less importance, the thin radiating shield is critically dependent on the maximum rate of heating that may be encountered, and a momentary very high heating rate, resulting from poor guidance caused by high surface temperature, may be disastrous.

Recent experience with various heat-protection methods during hypervelocity flights has demonstrated that both heat sinks and ablative materials are practical and have considerable margins of safety which can be used for increased performance. However, the advantage of ablative heat protection is in the inherent weight saving, a saving of 40 : 1 over the heat-absorbing non-melting types of heat sink being feasible in some instances.

The safety factor for ablation cooling systems, at least in the transient state for excessively large heat fluxes, is derived from their built-in stability. The rate of sublimation adjusts itself automatically to the rate at which the heat is applied, an increased heating rate being blocked, so to speak, by increased sublimation.

* Head Thermodynamics Engineer, Missiles and Structures Laboratory, Electronics & Avionics Division, Emerson Electric Mfg. Co., St. Louis, Missouri, U.S.A.

Several aspects of hypervelocity flights make ablation cooling very attractive, one of these being the extremely high environmental temperatures, which are, in fact, so high that chemical bonds of materials subjected to them are broken, with tremendous heat-absorbing results. However, one of the major questions which may affect the future use of ablative materials is their ability to maintain a reproducible aerodynamic shape, and this is of particular importance where ballistic trajectories are considered. Other problems of particular concern to a designer considering the use of currently publicized ablative materials include their susceptibility to thermal shock, differential thermal expansion, the ability to offer proper thermal control, and temperature control, where temperature-sensitive equipment is used.

A typical member of the family of ablative materials is Teflon, which depolymerizes into a monomer on exposure to high heat fluxes. This monomer has a very high vapour pressure and normally passes directly into the vapour phase without going into the liquid phase, i.e., it sublimes, although the liquid phase is possible in the case of simultaneous exposure to high pressure. At higher temperatures, some of the incompletely depolymerized polymers diffuse to the surface, and several major chemical reactions can occur. Owing to its combination of molecular-structure, thermal-conductivity, and thermal-expansion properties, Teflon is easily susceptible to spalling on exposure to high temperature gradients. Furthermore, it is normally manufactured in sheets which must be fabricated to a particular contour and which require special glues and the use of high pressure and temperatures for final adhesion. However, the greatest disadvantage in this respect lies in the fact that one vital component, i.e., the glue, is known to fail on exposure to high surface shears and temperatures.*

The "Thermo-lag" Method of Temperature Control

Intended expressly to overcome the inherent drawbacks of existing methods of temperature control of hypervelocity and space vehicles, including those of current ablative materials, the " Thermo-lag " method has been and still is being developed as a practical solution to a number of hitherto insurmountable problems in connection with missile and space-vehicle cooling.

Essentially, " Thermo-lag ", which has already proved extremely successful as a heat dissipator in a number of field applications in connection with hypervelocity flights, comprises a family of patented sublimating paint formulations which, mixed and applied like paint with conventional spray, brushing, or dipping equipment, cures at virtually room temperature, and bonds itself molecularly to the material on which it is applied, without the need for adhesives or other bonding materials. The combination of the latent heat of sublimation, specific heat, thermal conductivity, transpiration effect by the gases passing through the solid matrix, increase of the boundary layer with the low-molecular-weight gases, heat shielding, and decomposition or ionization of the sublimed gases at high-temperature extremes acts as the heat sink.

It is also possible to vary the surface thermal emissivity by a judicious choice of formulations when radiant emission becomes of sufficient importance. All other physical and thermodynamic properties remain basically unchanged. Since the temperature of sublimation is not a function of the rate of quantity of heat input and hence of accurate temperature control, these formulations are superior in this regard to ablative processes currently in use on some missile nose-cones. In addition, they can be conveniently applied on any contour by simple and conventional painting techniques, without any requirement for pressure, excessive temperature, or forming tools. Also, " Thermo-lag " bonds well to properly cleaned surfaces, and so far has been successfully applied to steel, aluminium, magnesium, copper, molybdenum, titanium, and various polyester, phenolic, and epoxy laminates. The vapours of the formulations have exhibited no toxic properties, while accelerated storage tests have failed to indicate any signs of surface corrosion or deterioration due to humidity.

Outstanding advantages of these formulations appear to be reproducibility, temperature and heat control, simplicity of application, light weight, and potential low cost, compared with that of other techniques. Also, by varying the constituents of the mixture and application thickness, the sublimation temperature and total vaporizing time can be altered and predicted with good accuracy ($\pm 10°F$).

The application of " Thermo-lag " is not restricted to areas directly exposed to high thermal environment. At times, it may be desirable to use it as a jacketing material in the same way as water. However, no artificial jacket is needed in this case. Several formulations of the desired sublimation temperature have been developed, the basic difference, when used as a jacket, being that these formulations, after curing, provide coatings which are sufficiently porous to permit the passage of sublimed gases from the interface. " Thermo-lag " compounds so far under development include the range between 200° and 1200°F, though higher or lower temperature control ranges have been considered and are deemed realistic.

These compounds are at present being considered for the temperature control of electronic, hydraulic, and structural components, flash-back shields, rocket nozzles, resonance suppressors, and fairing, wing, and fin surfaces, as well as nose-cones. Applications at present under advanced testing include the " Minute-Man " intercontinental ballistic missile, the " Polaris " submarine-launched ballistic missile, the " Samos " satellite, and the X-7 hypervelocity research vehicle.

" Thermo-lag " formulations are already being used as a protective coating for the " Little Joe " capsule now undergoing tests, and are also being investigated as a coating against aerodynamic heating of the " Mercury " man-carrying capsule. Other areas of field application include the " Honest John " rocket programme, where it is used for the thermal protection of the powerplant nozzle and the resonance suppressor. In the case of the nozzle, a special formulation which sublimes at 230°F has been used in the same way as a water jacket, except that, as already mentioned, no actual jacket is required. As a result, improved strength characteristics have been obtained by reducing the metal temperature and, at the same time, improved accuracy has been achieved by eliminating possible dimensional distortion.

Although the Emerson company has not yet developed the commercial possibilities of " Thermo-lag " formulations, it is believed that they have potential widespread applications in various high-temperature processes and may eventually replace many conventional insulating materials.

* The author's views on the suitability of Teflon as an ablative material for the temperature control of hypervelocity and space vehicles appear to be in contradiction to those expressed in a research study by E. I. duPont De Nemours & Co., as reported in *Machine Design*, January 7, 1960, page 34. *Editor, E.D.*

Turning Metals with Vibratory Cutting Tools

By V. H. Podurayev and Yu. E. Zaharov

From *Stanki i Instrument*, Russia,
Vol. 30, No. 12, 1959,
pp. 11–16, 18 illustrations

The increasing use of hard-metal and ceramic cutting tools demands greater attention to the problem of chip formation and chip disposal from the cutting zone. In the majority of turning operations, the chips leave the component in the form of long continuous spirals which wind around protruding parts of the machine or the tool itself, or fall into recesses or openings, impairing the quality and speed of machining and causing an increase in the wear of machines and tools. In addition, high-temperature flying chips frequently cause injury to operators. Furthermore, chips make the working area untidy, and their collection and transport away from the machine are troublesome.

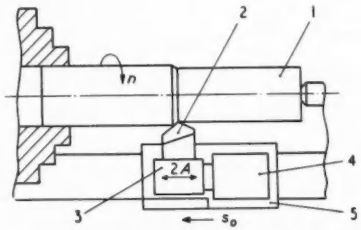


Fig. 1. Schematic arrangement of a vibratory-cutting set-up. (1) Workpiece. (2) Tool. (3) Toolholder. (4) Vibrating support. (5) Saddle.

These difficulties are amplified in the case of automatic machines and automatic production lines. Conventional methods of breaking chips into small pieces by means of chip-breakers do not effectively overcome these difficulties and, in any case, chip-breakers absorb a considerable amount of power. In one of the more recent methods suggested for solving the problem of chip-breaking and disposal, vibrations are imparted to the cutting tool, thus ensuring that the chips are broken into extremely small pieces. Also, under certain favourable conditions, this method improves the efficiency of metal cutting and reduces the cutting force required, as well as tool wear. In this connection, a two-year research programme has recently been carried out in Russia to investigate optimum conditions for chip-breaking and to assess the influence of vibrations on the accuracy and surface finish of the machined component, and also on tool life.

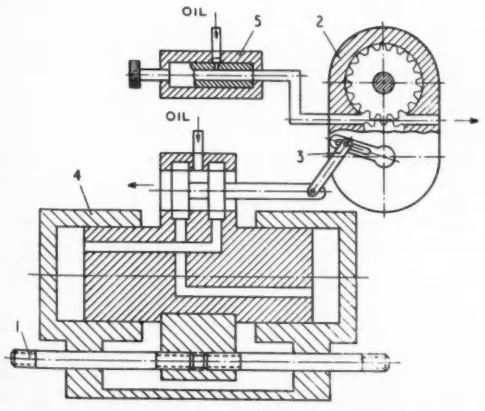


Fig. 2. Hydraulic mechanism of the vibrating support. (1) Connecting rod for the toolholder. (2) Hydraulic motor. (3) Amplitude adjustment. (4) Hydraulic actuator. (5) Frequency-control valve.

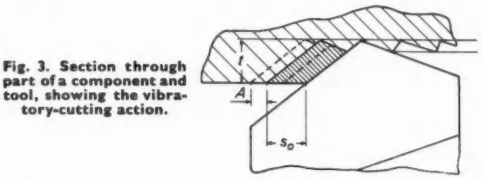


Fig. 3. Section through part of a component and tool, showing the vibratory-cutting action.

The schematic arrangement of "vibratory cutting" is given in Fig. 1, which shows part of a lathe with a special support that, during cutting, imparts vibrations to the toolholder and thus to the tool in the direction of the longitudinal feed. Details of the hydraulic arrangement of the support can be seen in Fig. 2. During turning with a cutting speed n, a longitudinal feed s_o, and a depth of cut t, the cutting edge of the tool will oscillate about its mean position with an amplitude A, as indicated in Fig. 3.

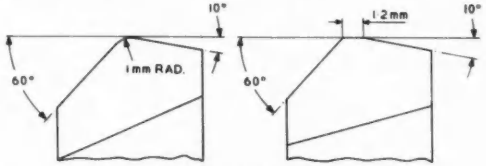


Fig. 4. Types of tool tips used.

For all experiments, two types of specimens were used, i.e., (1) bars made of a 0·5% carbon steel, hardened to from 197 to 218 BHN and (2) bars made of a chrome steel, containing 0·45% carbon and hardened to 28 to 30 R_C, the diameter of the specimens being 26 to 28 mm and their length 470 mm. Two different configurations of hard-metal tool tips were employed, of the types shown in Fig. 4. For comparison, tests were also carried out without vibrating the tool, but with the same types of cutters, which, however, were provided with chip-breaking grooves. The cutting speed in all cases varied from 18 to 45 m/min, the longitudinal feed from 0·1 to 0·42 mm/rev, and the depth of cut from 0·5 to 3 mm.

Chip-Breaking under Vibratory Cutting

One of the basic advantages of vibratory cutting is that it produces short chips, which can be easily removed from the vicinity of the cutting zone and transported away from the lathe. The main factors influencing the effectiveness of vibratory cutting are the direction, amplitude, and frequency of vibrations imparted to the tool, and the magnitude of the vibrating force. It has been shown experimentally that optimum chip-breaking and surface finish can only be achieved if the vibrations are

parallel to the longitudinal feed. As regards the magnitude of the cutting force, this is evidently determined by the magnitude of the hydraulic pressure acting on the toolholder. During tests to determine the most suitable pressures, it was found that, when the longitudinal feed was set to a constant value of 0·42 mm/rev, and the depth of cut varied between 1 and 3 mm, optimum chip-breaking was achieved with a hydraulic pressure of 40 atm for a full-wave amplitude of 0·6 mm and a frequency of 38·3 cps, this amplitude and frequency having previously been determined as being the most favourable.

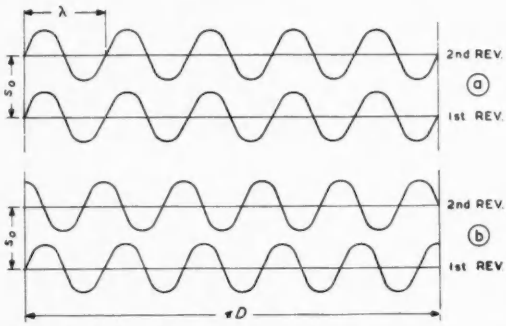


Fig. 5. Path of the tool along the periphery of the component, with (a) $i = 0$, and (b) $i = \frac{3}{4}$.

In order to study the mechanism of chip-breaking, the sinusoidal vibrations generated during one revolution can be superimposed on the periphery of the component. Under certain conditions, i.e., when the number of vibrations is any multiple of the rotational speed of the component, an integral number of sinusoidal waves can be accommodated on the periphery, as shown in Fig. 5a. However, in the general case, a certain part of one wave cannot be accommodated on the periphery, so that the vibrations of the subsequent cut will be out of phase, as indicated in Fig. 5b, this irregularity in the pattern of waves contributing to the chip-breaking action of the vibrations. The wavelength λ is found from the following equation:—

$$\lambda = v/f = vT \qquad (1)$$

where v is the cutting speed, f is the frequency of vibration, and T is the period of vibration.

The length which cannot be accommodated on the periphery of the component can be expressed as

$$i\lambda = (k+1)\lambda - \pi D \qquad (2)$$

where i is the fraction of one wave which cannot be accommodated on the periphery, k is the integral number of waves which can be accommodated on the periphery, and D is the diameter of the component.

Owing to the vibrations which act in the direction of the longitudinal feed, the instantaneous value of feed s_i will oscillate about its mean value, and this instantaneous value can be expressed as

$$s_i = s_o + 2A \sin(\pi i) \cos(\omega\tau - \pi i) \qquad (3)$$

where $2A$ is the full-wave amplitude of vibrations generated, τ is the time, s_o is the mean value of the feed, and ω is the angular frequency of vibration.

If $i = 0$, $s_i = s_o$ at any instant, and no chip-breaking takes place, the conditions in this case being similar to those occurring during conventional cutting without vibrations. In all other cases, the phase difference causes a variation in the width of chips from zero to maximum, this variation being one of the primary causes of chip-breaking. The greatest variation in chip width will occur at a value of $i = \frac{1}{2}$, in which case the maximum value of instantaneous feed is $s_o + 2A \sin(\omega\tau)$.

As it is possible to vary the instantaneous magnitude of the feed between its mean and maximum values, the width of the chips can also be varied sinusoidally within a wide range. In actual practice, however, such a wide variation is unnecessary, as experiments have shown that chip-breaking is completely satisfactory at any frequency which is not less than 10% out of phase with the rotational speed of the component. The shape and dimensions of the chips formed depend largely on the frequency of vibrations. At high frequencies, the chips resemble filings, at lower frequencies they form short spirals, and at still lower frequencies they form longer continuous spirals, while at a frequency of $f = n$, or $f = kn$, no chip-breaking takes place, and the chips formed are completely similar to those obtained by conventional turning.

The mechanism of chip-breaking during vibratory cutting is also influenced (a) by the concentration of internal stresses at the narrower sections of the chips, and (b) by the constant change of internal stresses which depend on elastic deformations occurring in the component-tool force system. The breaking-off point of the chips is usually either at the root or in its vicinity. With $i = \frac{1}{2}$, the length l of a chip can be calculated from $l = \pi v/2\omega$.

These theoretical assumptions have been wholly confirmed by subsequent experiments.

Machining Accuracy

During vibratory cutting, two types of vibrations have a bearing on the accuracy of machining, i.e., (1) the vibrations generated parallel to the direction of feed by the vibrating support, and (2) the radial vibrations which occur in all turning operations due to the component-tool force system, the latter type of vibrations having undoubtedly a decisive effect on the accuracy of cutting. The magnitude of errors caused by radial vibrations depends essentially on the rigidity of the system, and, as it has been clearly established that the vibrating support has a rigidity approximately equal to that of a conventional support, it can be assumed in theory that vibratory cutting does not cause any deterioration in machining accuracy.

In order to verify the above assumption, a number of chrome-steel specimens were turned with and without the use of the hydraulic vibrating support. For conventional cutting, the tools were again provided with chip-breaking grooves, while, for vibratory cutting, five different frequencies, i.e., 5, 10, 15, 20, and 23·5 cps, and six different full-wave amplitudes, i.e., 0·3, 0·4, 0·5, 0·6, and 0·7 mm, were used. This series of tests showed that the average error in conicity was between 0·01 and 0·06 mm, the maximum conicity being 0·13 mm in the case of conventional cutting, and 0·16 mm in the case of vibratory cutting at a frequency of 20 cps and a full-wave amplitude of 0·5 mm; the average error in ovality was between zero and 0·002 mm, the maximum ovality being 0·06 mm in the case of conventional cutting and 0·07 mm in the case of vibratory cutting. Although the maximum errors appear to be somewhat higher with vibratory cutting, the average errors are about the same, and it can therefore be concluded that machining accuracy is practically unimpaired by these vibrations.

Surface Finish

In order to achieve smooth and clean surfaces, it was found essential to analyse the interaction of the frequency and amplitude of vibrations, and the machining conditions and tool geometry. It is well known that surface finish is generally affected by three major factors, i.e., (1) the movement of the tool relative to the component, (2) the occurrence of plastic deformations in the cutting zone, and (3) the elastic recovery of the metal after the tool has passed the cutting zone.

There are also other factors which influence the height of micro-irregularities, such as the roughness of the cutting edge and inhomogeneities in the workpiece material; these are, however, equally present in both vibratory and conventional machining operations and can therefore be disregarded.

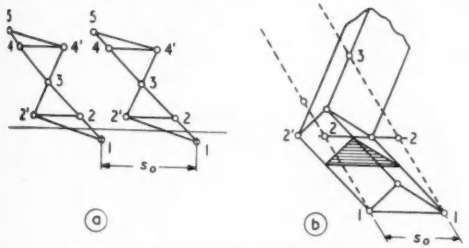


Fig. 6. Schematic representations of (a) the path of the tool, and (b) surface irregularity, with $f = n$ or $f = kn$.

Fig. 6 shows schematically the formation of peaks during vibratory cutting. In conventional turning, the base of micro-irregularities along the periphery is uniform and is equal in value to the feed. For ease of graphical representation of tool motion during vibratory cutting, the sinusoidal motion of the tool can be approximated by straight lines, Fig. 6a showing the first and second cut of the tool, the path of which follows the line 1—2′—3—4′—5, whereas, in conventional cutting, this path would be represented by a line 1—2—3—4—5. If $f = n$, or $f = kn$, the profile will remain constant along the periphery, but will change direction, as shown in Fig. 6b. The greater is the number of vibrations during one revolution of the component, the more breaks will there be in the peak line, and the larger is the amplitude of vibrations, the greater will be the deflection from a true helix.

If the frequency of vibrations and the rotational speed of the component are out of phase, the pattern of micro-irregularities considerably changes. Fig. 7 shows a geometrical representation of the irregularities formed during vibratory cutting for a value of $i = \frac{1}{4}$. In this case, the base, as well as the height, of the profile varies widely. However, the average height of the irregularities remains constant and equals that with conventional cutting.

To confirm these theoretical considerations, the profiles obtained by geometrical construction were compared with profiles measured by profilometers, which showed that, in practice, the irregularity is less pronounced, owing to the appreciable effects of plastic deformation and elastic recovery of the metal on surface finish.

Further experiments carried out under laboratory and actual operating conditions shed light on the relationship between the frequency of vibrations and surface finish. It was found that the surfaces obtained by vibratory cutting were inferior to those obtained by conventional cutting only under unfavourable conditions. Although

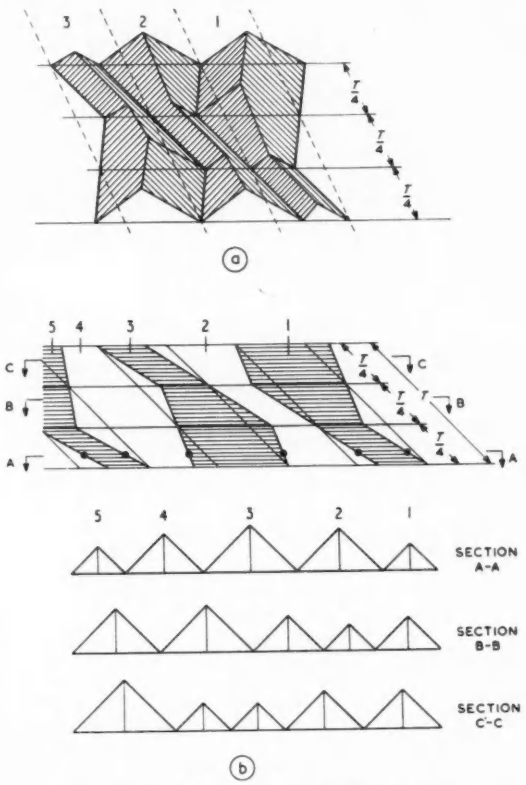


Fig. 7. Representation of irregularities formed during vibratory cutting with $i = \frac{1}{4}$, showing (a) a perspective view, and (b) cross-sections through the irregularities.

the selection of a suitable amplitude is also important in order to achieve good results, the major factor influencing surface finish appears to be the frequency of vibrations. In order to select the most suitable frequencies, the value of cutting speed must be carefully considered, longitudinal feed having very little effect on surface finish in this connection. To underline the interdependence of cutting speed and frequency, a dimensionless expression $\gamma = f/n$

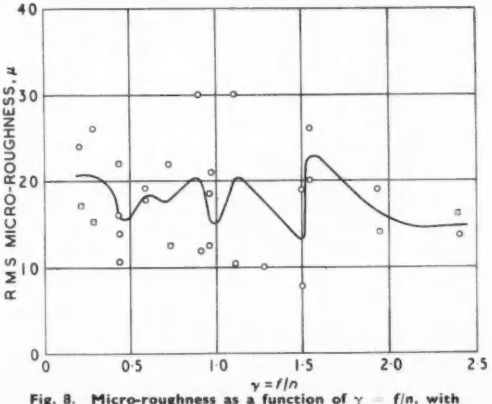


Fig. 8. Micro-roughness as a function of $\gamma = f/n$, with $\alpha = 2A/s_o = 1{\cdot}66$.

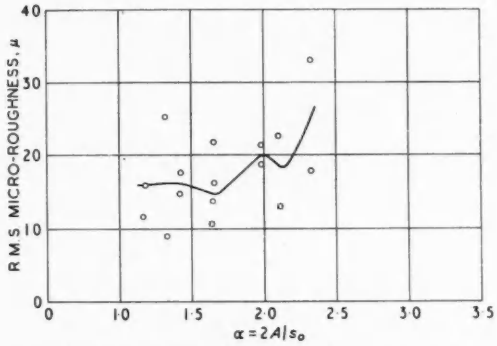


Fig. 9. Mirro-roughness as a function of $\alpha = 2A/s_o$, with $\gamma = f/n = 0{\cdot}436$.

is introduced. Fig. 8 shows the relationship between r.m.s. micro-roughness and γ at a depth of cut of 1·5 mm, an actuating oil pressure of 40 kg/cm², a control pressure on the hydraulic motor of 30 kg/cm², and an α-value of 1·66 (see below). The graph clearly indicates that there are three values of γ at which r.m.s. micro-roughness is at a minimum, i.e., at $\gamma = 0{\cdot}5$, 1, and 1·5 approximately. However, when $\gamma = 1$, $f = n$, and no chip-breaking takes place. The most suitable value was found to be $\gamma = 1{\cdot}5$, which also gave the finest chips.

A great number of experiments was also carried out in order to establish the relationship between r.m.s. micro-roughness and amplitude of vibrations, these experiments giving somewhat more consistent results than those concerned with the frequency of vibrations. The selection of a suitable amplitude is facilitated by the introduction of another dimensionless expression $\alpha = 2A/s_o$, the magnitude of r.m.s. micro-roughness expressed in terms of α being plotted in Fig. 9, which shows that optimum surface finish can be achieved with $\alpha = 1{\cdot}66$. Also, with values of α between 1·1 and 1·8, r.m.s. micro-roughness does not vary considerably; consequently, for optimum surface finish and chip-breaking the most suitable value of amplitude A is Cs_o, where the value of C varies between 0·6 and 0·9.

The experimental results were generally in good agreement with the theoretical assumptions, showing that, with suitable selection of frequencies and amplitudes, surface finishes comparable with those obtained by conventional cutting can be achieved with the new method.

Tool Wear

Basically, tool life is affected by the cutting forces applied to the cutting edge and to the whole tool and by the ability of the tool to resist the loads imposed. During vibratory cutting, an additional vibrating force must be taken in account, the magnitude of which constantly

(*Concluded on page 98*)

The Planche Four-Cylinder Engine with External Combustion Chamber

By R. PLANCHE
From a monograph published in France,
16 pp., 6 illustrations

RECIPROCATING internal combustion engines, whether of the diesel or of the spark-ignition type, have two main limitations, i.e., (1) the need for a compression chamber into which the fuel or fuel/air mixture is injected, and (2) the impossibility, owing to compression and expansion in the same cylinder, of continuing expansion of the gases to a sufficiently low pressure before they are discharged.

The Planche engine has been designed to avoid these drawbacks, but still retains as many as possible of the usual features of internal combustion engines. This four-cylinder engine, with cylinders of different bore, operates on a constant-pressure cycle and has an external combustion chamber, cylinders (1) and (2) operating as a two-stage air compressor, with cylinders (3) and (4) designed for expansion in two stages, as indicated in Fig. 1. Air is drawn in at atmospheric pressure and ambient temperature and is discharged from cylinder (1) at a pressure of 100 psig and a temperature of 200°C. It is then cooled down nearly to ambient temperatures in a finned cooler *R* and supplied to cylinder (2), in which it is further compressed to approximately 900 psig, again reaching a temperature of about 200°C. The air discharged from this cylinder is passed through a heat exchanger *E*, which makes use of the heat of the exhaust gases to raise its temperature to 330°C. It is then supplied to the combustion chamber *C*, into which the fuel (kero-

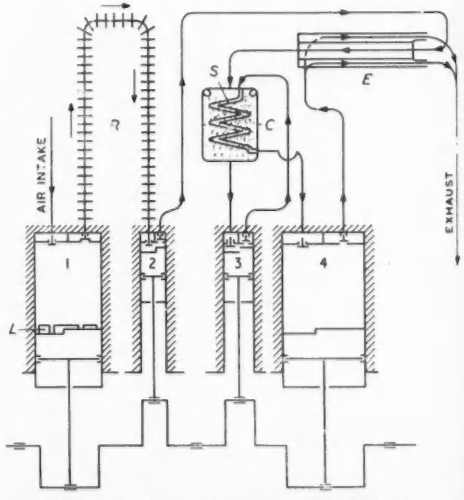


Fig. 1. Schematic diagram of the Planche four-cylinder engine with external combustion chamber.

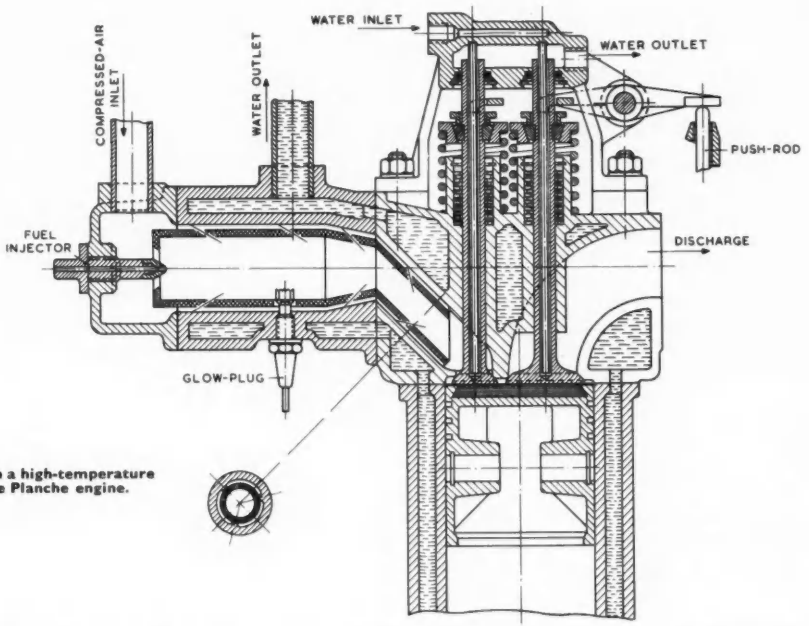


Fig. 2. Section through a high-temperature cylinder head of the Planche engine.

sene or gas-oil) is continuously injected. The combustion gases issuing from this chamber have substantially the same pressure as previously (900 psig), but their temperature is 950°C.

These gases expand to 100 psig in cylinder (3), whence they emerge at a temperature of about 350°C; they are then reheated to 950°C by passing through a spiral coil *S* situated inside the combustion chamber *C*, before expansion occurs in cylinder (4) down to a pressure just slightly above atmospheric. They then pass through the heat exchanger *E* before being exhausted to the atmosphere at a temperature of 220°C.

As indicated in Fig. 2, the combustion chamber, designed as a temperature-resistant insert with a circular cross-section supported only at three points around its periphery, is enclosed in a water-cooled block connected to the inlet side of cylinder (3). The injection pressure, provided by a small plunger pump driven by the engine, is kept slightly higher than the maximum pressure of the gases by means of a differential-pressure controller.

The cooler and the heat exchanger, both of which can be mounted under the chassis of road vehicles, can be designed as simple finned tubes, the outer of the two concentric tubes of the heat exchanger being provided with rock-wool insulation. The heat exchanger, which is of ample capacity, to minimize back-pressure, can also serve as a silencer.

Although the bores of the cylinders must be chosen in accordance with their individual functions, the pistons can have whatever weight is required for suitable balancing of the forces and couples acting on the crankshaft. The basic idea is that, with constant pressure at the end of expansion, each cylinder should deliver a volume proportional to the final temperature of the gases it contains.

The most appropriate construction for an engine of this type would seem to be the opposed-piston horizontal design, with the large-bore and small-bore cylinders arranged opposite each other.

The valves, with labyrinth-type seals, are actuated by means of the usual type of cam-operated valve-gear. The inlet and outlet passages can be of comparatively small dimensions but are designed to obtain adequate filling. Cylinder (1) has, in addition, air-inlet ports *L* (Fig. 1) near the bottom-dead-centre position of the piston; these ports can be connected to an intake near the front of a vehicle, so as to obtain a slight ramming effect.

Because the individual cylinders have different bores and operate only within certain ranges of temperature and pressure, their clearances can be kept smaller than in a conventional engine. Moreover, the heat losses through the cylinder walls will be less than those of coventional four-cylinder engines because only two of the cylinders receive gases at high temperature.

The flexibility of the power-plant, i.e., its ability to cope with various loads and speeds, can be expected to be at least equal to that of the usual four-cylinder unit, since the pistons are displaced under constant pressure, ending with a gradual expansion, with each of the expansion cylinders in turn acting as a power cylinder, thus giving two power strokes per revolution, as in the normal four-cylinder four-stroke engine.

For starting, cylinder (1) can be provided with a device which limits its compression to 45 or 55 psig, and which is disconnected when normal running conditions are reached. Load changes can be controlled by means of the fuel rack. Six- or eight-cylinder versions, with two or three stages of intercooling between the compressor cylinders, and two or three reheaters or partial combustion stages between the expansion cylinders, are also possibilities included in the design of this engine. An increase in the number of cylinders and in the number of combustion chambers has a beneficial effect on efficiency, and it is expected that the four-cylinder engine should have an efficiency of 35%. For the six-cylinder version, calculations indicate a considerably higher theoretical efficiency.

The Suitability of Various Gases as Working Media for a Nuclear Reactor-Gas Turbine Combination

By W. Pflaum and D. Reiher

From *MTZ*, Germany, Vol. 21, No. 1, January 1960, pp. 20–22, 3 illustrations

In this investigation, various gases have been examined with regard to their possible utilization as coolants and working media in a closed circuit comprising a nuclear reactor and a gas turbine. A simple co-axial arrangement of gas turbine and compressor has been chosen (Fig. 1), because the results obtained from such a basic arrangement are also indicative of the probable behaviour of other circuits.

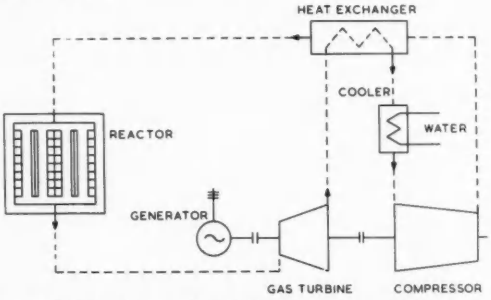


Fig. 1. Circuit diagram of a closed-cycle gas turbine and nuclear reactor.

Of the gaseous elements and their combinations available in the periodic system, selection has been limited to helium, neon, argon, krypton, xenon, hydrogen, heavy hydrogen (deuterium), nitrogen, oxygen, and carbon dioxide. The halogens (fluorine, chlorine, bromine, and iodine) have not been considered because of their strong chemical activity. Other polyatomic combinations, apart from carbon dioxide, are very unstable under radiation and are hardly suitable for the purpose.

Effects of Irradiation

The gases selected were first compared with regard to the physical properties required from a reactor coolant, e.g., low neutron absorption. As a result, it became apparent that the rare gases argon, krypton, and xenon become gamma-radiation emitters under the influence of neutron bombardment and are therefore not suitable for a closed circuit of the type under discussion. The other gases considered fulfil, with certain reservations, the essential physical requirements of a reactor coolant and, on this basis, their evaluation, in descending order of merit, is as follows:—(1) Deuterium, (2) helium, (3) hydrogen, (4) oxygen, (5) carbon dioxide, (6) nitrogen, (7) neon.

Influence of Thermodynamic Properties

Following this evaluation, calculations have been made for each of these gases with a view to obtaining an impression of their thermodynamic behaviour. The calculations have been based on isobaric heat supply and heat removal, and adiabatic compression and expansion, and have given indications of the possible efficiency attainable, as a function of various parameters. The influence of turbine inlet temperature on efficiency for different temperature and pressure losses is shown in Figs. 2 and 3 respectively. However, it should be appreciated that, quite apart from pressure losses, pressure ratio also has an effect on efficiency and, for optimum efficiency, there is a corresponding optimum pressure ratio which varies with the gas used and the turbine inlet temperature.

In order to consider closely the dependence on temperature of the specific heat of the diatomic and polyatomic gases, enthalpy/entropy diagrams have been compiled for these gases and show that, at relative total pressure losses of 10% to 20% in the plant, higher efficiency can always be achieved with the diatomic or triatomic gases,

Table I: Comparative Efficiencies with Different Pressure Drops.

Pressure Drop	He, Ne	N_2	H_2	D_2	O_2	CO_2
10%	0·930	1	1·037	1·022	0·998	0·980
20%	0·836	1	1·017	1·014	0·990	1·026

as compared with the monatomic rare gases, as indicated in Table I, which is based on a turbine inlet temperature of 700°C, a compressor inlet temperature of 20°C, a turbine efficiency of 90%, a compressor efficiency of 87%, and a temperature loss in the heat exchanger of 50°C.

Influence of Compressor and Turbine Parameters

Assuming an optimum pressure ratio for optimum efficiency, the influence of the various gases on different operational and dimensional parameters of the compressor and turbine was then investigated, a generator of 3-MW output being taken as the basis of calculation. Taking into account the number of stages and the dimensions of the compressor and turbine at constant pressure for all these gases, carbon dioxide proved to be best suited for gas turbines. After eliminating oxygen because of its oxidizing effects the suitability of these gases for use in gas turbines can be classified in descending order of merit as follows:—(1) Carbon dioxide, (2) nitrogen, (3) deuterium, (4) helium, (5) neon, (6) hydrogen.

Influence on Heat-Exchanger Volume

Examination of the influence of the various gases on the dimensions of the heat exchanger was based on a constant flow cross-section. Corresponding to the various thermal properties of the gases, different volumes for the heat exchanger are required, helium and hydrogen needing the smallest dimensions and carbon dioxide the

Table II: Volume and Pressure-Loss Factors for Heat Exchangers.

	N_2 $\varepsilon = 2{\cdot}4$	He $\varepsilon = 2$	Ne $\varepsilon = 2$	H_2 $\varepsilon = 2{\cdot}4$	CO_2 $\varepsilon = 4$
Volume	1	0·762	0·875	0·810	1·065
Pressure drop	1	0·445	1·851	0·100	0·382

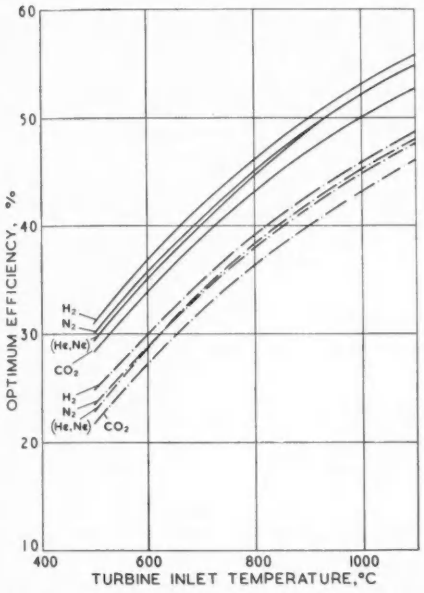


Fig. 2. Optimum efficiency as a function of turbine inlet temperature, neglecting pressure losses, and assuming a compressor inlet temperature of 20°C and compressor and turbine efficiencies of 87% and 90% respectively.
Solid lines: Temperature loss of 50°C in the heat exchanger.
Dotted lines: Temperature loss of 100°C in the heat exchanger

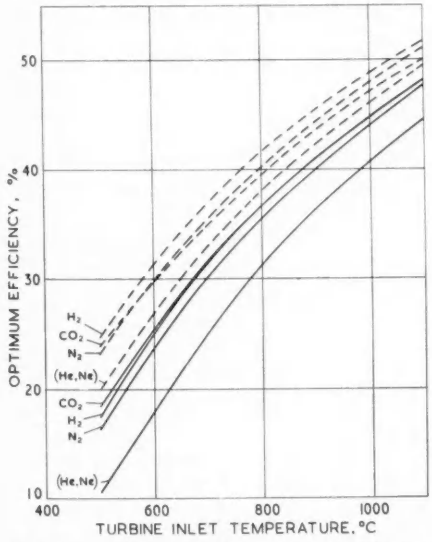


Fig. 3. Optimum efficiency as a function of turbine inlet temperature, assuming a temperature loss in the heat exchanger of 50°C, and other conditions similar to those in Fig. 2.
Solid lines: Pressure loss of 20%.
Dotted lines: Pressure loss of 10%.

largest, with neon and nitrogen in between, as shown in Table II, which also includes the optimum pressure ratio ε for each of the gases concerned. If pressure loss is also taken into account, classification in descending order of merit, with regard to heat-exchanger volume, is as follows:—(1) Hydrogen, (2) helium, (3) carbon dioxide, (4) nitrogen, (5) neon.

Deuterium has been excluded from these observations because some of the values for the selected temperature range were not completely available.

Influence of Technological Properties

With regard to the technological behaviour of the various gases, their effects on steel have been particularly borne in mind, the rare gases helium and neon being most suitable in this respect. Oxygen is totally unsuitable, owing to its tendency to oxidize. The use of hydrogen is, from the technological point of view, problematic because of its relatively high rate of diffusion and the danger of explosion. In the case of nitrogen, it must be appreciated that atomic nitrogen, produced by radioactivity in the reactor, may attack the thin-walled fuel elements, with the consequent risk of crack formation. The use of carbon dioxide is more or less limited by the composition of the steel.

Based on these technological considerations, and also on inherent sealing problems, the evaluation of the gases, in descending order of merit, is (1) neon, (2) helium, (3) carbon dioxide, (4) nitrogen, (5) deuterium, (6) hydrogen, (7) oxygen.

Cost

Finally, the cost of the individual gases has also been considered, the rare gases and deuterium being by far the most expensive. Based on the amount of gas required for a 3-MW plant, the following evaluation in terms of cost can be established: (1) Hydrogen, (2) oxygen, (3) nitrogen, (4) carbon dioxide, (5) helium, (6) deuterium, (7) a mixture of 75% neon and 25% helium.

Conclusions

Based on the above evaluations, an attempt has been made to find the gas with the best overall properties for use in the whole plant. As a result, the choice has been narrowed down to helium, neon, nitrogen, and carbon dioxide, the general suitability of which in descending order of merit is summarized in Table III.

TABLE III: COMPARATIVE OVERALL EVALUATION OF HELIUM, NEON, NITROGEN, AND CARBON DIOXIDE.

	1	2	3	4
Reactor properties	He	CO_2	N_2	Ne
Thermodynamic properties	N_2	CO_2	He, Ne	—
Compressor and turbine parameters	CO_2	N_2	He	Ne
Heat-exchanger volume	He	CO_2	N_2	Ne
Technological properties	Ne	He	CO_2	N_2
Cost	N_2	CO_2	He	Ne

As can be seen, none of these gases has optimum qualities from all points of view and, to select the most suitable medium, it is therefore necessary to make some compromise. Of these four gases, neon appears to be the least satisfactory, mainly because of its high cost and its relatively poor suitability for use in nuclear reactors. Similarly, nitrogen cannot be considered as particularly

(*Concluded on page 127*)

Improved Methods of Producing Metal Fibres

From *Steel*, U.S.A.,
Vol. 146, No. 2, January 11, 1960,
pp. 74–76, 3 illustrations

METALS in fibrous form have many potential applications. Thus, their density can be controlled for structural applications, while the ability to control their porosity makes them suitable for use in such items as filters, diffusers, mixers, flame-barriers, and battery plates. Similarly, combinations of metals, metal-ceramic systems, or metal-plastic systems could provide reinforced materials, e.g., for brake linings, combining wear resistance with good heat-transfer properties, or could engender a new family of fibre-reinforced plastics with superior impact characteristics and wear resistance.

It is not surprising, therefore, that there is a growing interest in fibre metallurgy, and manufacturing processes now under investigation involve both metalworking and textile techniques. An obvious method of manufacturing metal fibres is to start with wire, which can be made by standard drawing procedures and then cut to the desired lengths. However, although this method has the advantage of close control of the diameter and shape of the wire, which can even have its as-drawn shape modified by rolling, it can prove an expensive method, as the finer is the wire, the higher is the cost.

In many cases, wire is also the starting material for metal "wool". Steel wool is a continuous chip and, from the standpoint of collecting the product and the cost of the operation, turning such chips from a bar is not usually practical. With wire as the starting material, the cutting edges shave off a chip as the metal moves past them, the sharp edges resulting from this cutting process and running along the length of the fibre accounting for the ability of the product to dig into softer materials.

The structure of metal fibres produced by these methods has the typical grain pattern of wrought material, with fine grain sizes which are elongated in the direction of working.

In the manufacture of synthetic fibres of the type used in textiles, the basic process used is extrusion, in which the material is squeezed through a head containing holes of appropriate size. In this connection, it is interesting to note that a group of American patents is concerned with producing metal fibres by methods which are similar to those used in the production of textile fibres. In these new processes, molten metal is forced through an opening under controlled pressure, so that the fine stream produced is continuous. Variations in the method of cooling determine the shape of the filament cross-section.

In the earliest of these patents, the stream of metal impinges on a curved chill-plate, where it rapidly freezes, the resulting filament having a smooth underside which reproduces the surface of the chill-block, while the upper surface shows evidence of dendrites and shrinkage marks, since the fibre is formed by casting. The nature of the fibre is determined by controlling the temperature of the molten metal, the speed with which it leaves the orifice, the diameter of the orifice, and the surface speed of the rotating chill-block at the point of contact. Orifice size mainly determines the width of the filament. Increasing temperature and decreasing ejection velocity make the castings thinner, and the relation between impingement velocity and ejection velocity determines whether the filaments will be continuous, discontinuous, or even flakes or powder.

Other arrangements have been developed for collecting the filaments, such as a rotating collection ring, and for chilling the metal, such as a continuous belt. In these methods, a metal heat-transfer surface is used, and the fibres have a characteristic flat bottom and a rounded upper surface. Successful filaments have been made from a number of metals.

Round filaments have been produced by "floating" the molten metal on a gas stream. The metal source is much the same as that used for the other methods described, and the velocity of extrusion through the orifice is in the same range, but the metal is directed into a gas or air stream which is approximately horizontal, as shown in Fig. 1. By the time it has moved down through the stream it is solid, the relationship between the speed of the gas and the diameter and velocity of the metal stream determining the final diameter of the filament. If the gas velocity is sufficiently high, the filament will be drawn out, and it can then be smaller than the diameter of the orifice in the feeding head. Still higher velocities will produce staple fibres whose length can be controlled by adjusting the process variables.

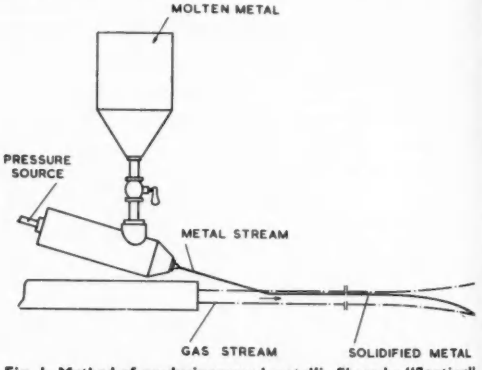


Fig. 1. Method of producing round metallic fibres by "floating" the metal stream on a gas stream.

The process is similar to that used for the production of fibres from molten glass. Glass, however, is relatively viscous. For this reason, the gas stream is often heated and is generally used at high velocity to thin out the filaments, colder streams producing coarser glass fibres.

Another method of making round fibres is to drop the stream of molten metal vertically. Again, it is discharged from an orifice, but flows from a height and, by the time the metal reaches the collector at the bottom of the tower, it has solidified into a filament. If the tower is an enclosed cylinder, a cooling gas may be passed upwards through it. The gas may also be used to provide a protective atmosphere for materials which would oxidize in air.

If the requirement is for a filament composed of more than one metal, but not alloyed, similar equipment can be used, the nozzle in this case being fed from two metal streams. As the rapid chilling of the fibre does not permit much mixing, bimetallic fibres can be produced, e.g., with tin on one side, lead on the other, and an

alloyed layer between them. Similarly, an outer surface of one metal can be produced on an inner core of another metal. No special methods are required for chilling the filaments, and the same range of shapes can be produced with the special nozzles needed for making bimetallic fibres. Naturally, however, the restrictions on bimetallic combinations would be greater, since more variables would have to be controlled.

The use of these patented methods should make it possible to produce fibres ranging from flat, almost rectangular cross-sections to round cross-sections, in varying diameters and thicknesses, and in lengths ranging from continuous to a few times the diameter of the filament. Materials can be any of a wide range of ferrous and non-ferrous alloys, or combinations. So far, the refractory metals are too difficult to handle.

In the manufacture of textile fibres, increasing the output of a particular material is usually effected by setting up another spinning-head system, which may be fed from the same source of liquid material. The same principle would seem to apply in the production of metallic fibres by these methods. Where the wrought-structure characteristic of wire is not required, these filament-casting techniques should lower production costs.

Strain-Gauge Measurements over Long Distances

By A. DEVACHT

From *La Recherche Aéronautique*, France,
No. 73, November/December, 1959,
pp. 37-39, 5 illustrations

STRAIN measurements with resistance-wire strain gauges are usually made in conjunction with Wheatstone bridges which are situated fairly close to their source of supply and associated equipment, and the short cables connecting these units cause no distrubance. However, when distances of the order of 100 ft have to be considered, as in the case of aerodynamic force balances in wind tunnels, the cable resistances and their variations due to temperature can introduce errors in the measurements. These errors are negligible for large values of strain, i.e., for large values of bridge unbalance $\Delta R/R$, but become major factors when ΔR/R values are in the region of 10^{-5} to 10^{-4}.

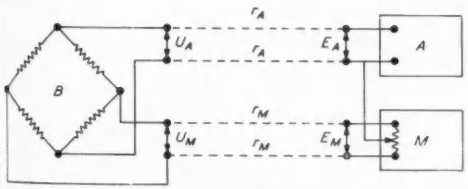


Fig. 1. Conventional strain-gauge circuit.

In the strain-gauge circuit shown in Fig. 1, the bridge B is supplied from a source A and transmits its signals to a measuring unit M. For measurements by the null-balance method, the bridge unbalance $\Delta R/R$ is compensated by a network represented by a potentiometer which maintains the voltage E_M at zero. This method makes the measurement independent of the input voltage U_A, so that, in principle, the length of the supply cables, which have a resistance r_A, is no longer a factor. However, the resistances r_M of the signal-output cables (and also that of one of the supply cables for the return of current) are in series with the balancing circuit and can cause errors in indication—a feature which makes results from the null-balance method dependent on distance.

To obtain correct values, an additional measuring circuit is required, which will provide the ratio U_M/U_A, since this is proportional to $\Delta R/R$. Unfortunately, U_A and U_M are not obtainable directly but only through the known values of the terminal voltages E_A and E_M, which depend on cable resistances. These, however, can be cancelled out by suppressing the circulating currents in the connecting cables by means of a measuring method using opposing voltages. The resulting circuit, shown in Fig. 2, thus requires six leads, instead of four. The compensating voltages $-U_A$ and $-U_M$ are obtained, for instance, from servo-operated potentiometric recorders. Although this circuit eliminates the effect of cable resistance, it does not give the ratio U_M/U_A directly and requires two measuring instruments M_A and M_M to obtain one result.

The ratio U_M/U_A can, however, be obtained automatically if the voltage U_M of the strain-gauge bridge supplied with a voltage U_A is counteracted by an opposing voltage $-U_A$ from an auxiliary bridge supplied with the same voltage U_A, as shown in Fig. 3. This circuit, although involving additional connections and circulating currents, has interesting features, which can be analysed by considering Fig. 4. For the sake of simplicity, it is assumed that the strain-gauge bridge 1-3-2-4 is symmetrical, with equal resistances R_1 and R_2 in the opposed arms. The auxiliary bridge has equal resistances ρ in all four arms. The long cable connections are represented by symmetrical resistances r_1 and r_2 between corresponding junctions (4-8, etc.) of the two bridges.

A simple analysis gives the voltage ratio U_M'/U_A' between the points 7-8 (U_M') and 5-6 (U_A'), which

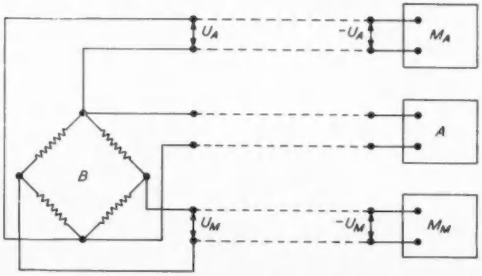


Fig. 2. Strain-gauge circuit requiring six leads, eliminating the effects of cable resistance.

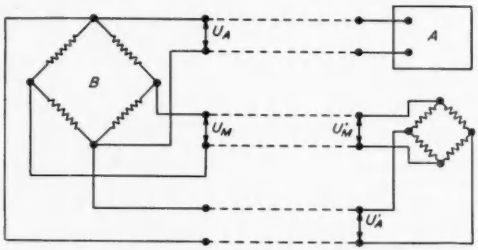


Fig. 3. Strain-gauge circuit with an auxiliary bridge.

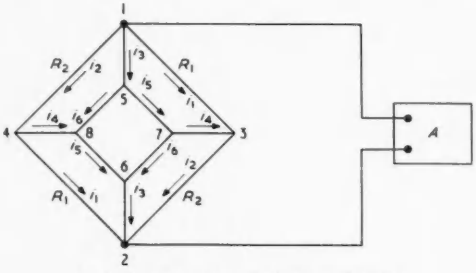


Fig. 4. Analysis of the circuit shown in Fig. 3.

can be taken as a measure of the bridge response, as follows:—

$$U_A' = E[1 - (2r_1/a)]$$

$$U_M' = E\rho(R_1 - R_2)/[(R_1 + R_2)b + 2R_1R_2]$$

where $a = 2r_1 + \rho$, and $b = 2r_2 + \rho$.

Introducing $R_1 = R + \Delta R$, and $R_2 = R - \Delta R$, the result is

$$U_M'/U_A' = \frac{a}{b + R - \left(\frac{\Delta R}{R}\right)\Delta R} \times \frac{\Delta R}{R}$$

The measurement will indicate bridge unbalance correctly if the first fraction is equal to unity, i.e., if

$$a = b + R - (\Delta R/R)\Delta R$$

or $r_1 \cong r_2 + (R/2)$.

The measured value U_M'/U_A' gives the rigorously true value of $\Delta R/R$, if the difference $r_1 - r_2$ is adjusted in accordance with the measured value of $\Delta R/R$. This adjustment could be made automatically, but is not necessary if the measured $\Delta R/R$ values are of the order of 10^{-3}. With $R = 100$ ohms, $\rho = 30{,}000$ ohms, and $\Delta R/R = 3 \times 10^{-3}$, the resulting error is 3×10^{-8}, which is quite negligible.

The circuit details are given in Fig. 5. B is the strain-gauge bridge (with $R_1 \cong R_2 \cong 120$ ohms), M the auxiliary bridge ($\rho_1 + \rho_2 = 33{,}000$ ohms), and p_1 and p_2 are 600-ohm potentiometers permitting the measurement of U_M' between terminals 7 and 8 as a function of U_A', since the null-balance potentiometer p_1 and the measuring potentiometer p_2 are supplied via terminals 5 and 6. The recording potentiometer, operated by the servomotor S, takes its input voltage from the sliding contacts of p_1 and p_2, adjusting the latter so as to maintain zero voltage. Tests with a measuring system of this type show that instrument indications remain unchanged when the

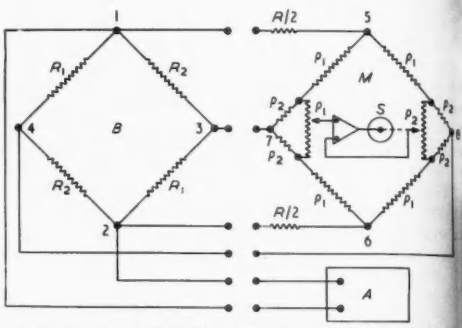


Fig. 5. Strain-gauge circuit with automatic compensation for lead resistance.

resistance of the connecting cables is varied from zero to 1000 ohms, independent of whether or not the $\Delta R/R$ output is due to a symmetrical action on the bridge.

The above analysis assumes equal line resistances, which are easily achieved in practice, since thermal influences act in the same manner on all the conductors in a common cable. Nevertheless, tests made with different line resistances show that, with a difference in resistance of 30 ohms between the two leads, the relative error does not exceed 0·1%.

It may be noted that the circuit described above does not involve more complications than conventional arrangements; in fact, it simplifies the equipment by making it possible to use, in the place of heavy cross-section cables, normal cables with leads of 0·2-mm² cross-section, or even smaller.

Turning Metals with Vibratory Cutting Tools

(*Concluded from page 92*)

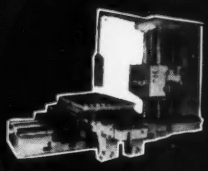
varies. Apart from the strength characteristics of the tool material, the resistance of the cutting edges plays an important role in meeting these loads.

The face of the tool is most liable to abrasion, particularly at low cutting speeds. Consequently, vibratory cutting appears to be hardly suitable for machining such materials as stainless steels, during the cutting of which low speeds (about 2 to 15 m/min) are usually employed. Tool life is also greatly influenced by the direction of vibrations. In this respect, vibrations parallel to the axis of the component have a less harmful effect than radial vibrations, which occur in both conventional and vibratory cutting and which contribute to the rapid wear of tool tips. The effect of these factors is, however, less pronounced with steels that are normally turned at high speeds.

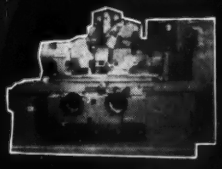
In general, it may be said that vibrations contribute to an increase in tool life. For instance, during tests, a round-nosed tool tip failed after 22·2 min of conventional cutting, while the same type of tool tip remained sound after 28·2 min of vibratory cutting under identical conditions. Similar results were obtained with other types of tool tips. Apparently, in all these cases, variations in speed, feed, and direction of cutting change the character of plastic deformation of the machined metal and have a beneficial effect on tool life. Also, these factors tend to reduce the load on the cutting edges—an effect similar to that observed during the ultrasonic machining of metals.

INTERNATIONAL MACHINE TOOL EXHIBITION 1960

The comprehensiveness of the range of fine machine tools by British, Continental and American makers sold by Charles Churchill enables a manufacturer planning production to cover his entire requirement from this one source, ensuring co-ordinated deliveries and the soundest technical advice. When production planning call in Charles Churchill and Company Limited.



PRODUCTION PLANNING WITH CHURCHILL



CHARLES CHURCHILL AND COMPANY LIMITED,
COVENTRY ROAD, SOUTH YARDLEY, BIRMINGHAM 25.

Lubrication Plus Protection

Mobilux Grease is a lithium base lubricant of excellent structural stability and purity. It is a new, general-purpose grease superseding conventional greases. It provides effective lubrication for the majority of grease applications over a temperature range from minus 20°F to 250°F. It is exceptionally resistant to water washing and contains special additives to prevent rust formation. Both in the laboratory and in the field Mobilux Grease has proved its outstanding efficiency as a lubricant and protector.

MOBILUX GREASE

Mobil

MOBIL INDUSTRIAL LUBRICANTS

British Industrial Developments

Instrument for Measuring Roundness, Parallelism, and Straightness

The great advantage of a new instrument manufactured by Hommel, of Mannheim, Germany, who are represented in the U.K. by Rubert & Co. Ltd., of Cheadle, Cheshire, is that it not only measures roundness circumferentially, but also, using the same stylus, can measure parallelism and straightness, thus providing a full three-dimensional description of the error of form of cylindrical components. Another innovation is an automatic centring device which is stated to be virtually infallible and which takes only a fraction of the time required by conventional methods. The instrument can measure a maximum diameter of 6 in. and a vertical height of 8 in., with a magnification of error of form of up to ×10,000.

The equipment essentially consists of four parts, i.e., the mechanical testing apparatus, the recording equipment, the control equipment, and the viewing equipment. The mechanical testing apparatus comprises a high-precision turntable with centring clamps which provide mechanical preliminary centring. No other adjustment is necessary, as high-precision centring is completed automatically. The contours of cylindrical specimens are traced by means of an electric tracer system fitted to a slide which moves on a vertical column of high accuracy, thus providing a reliable reference line. The column can be moved horizontally to provide a rough adjustment to the diameter of the specimen, the actual fine adjustment also being performed automatically. The tracer arms are easily interchangeable for tracing inside and outside diameters, and the tracer system is protected against damage while being moved towards the specimen. The smallest bore that can be measured is 0·12 in. in diameter, and the turntable has two speeds, i.e., 5 and 10 rpm.

The recording equipment (shown on the table at the left of the illustration) consists of two parts, i.e., a polar recorder for recording errors in roundness, with a radial magnification up to 10,000, and another recorder with a horizontally moving graph paper for measuring parallelism and vertical errors of form. The recorders are electrically connected to the turntable and to the vertical movements of the tracer system respectively. Vertical movements can be recorded in ratios of 1:1, 1:2, or 2:1.

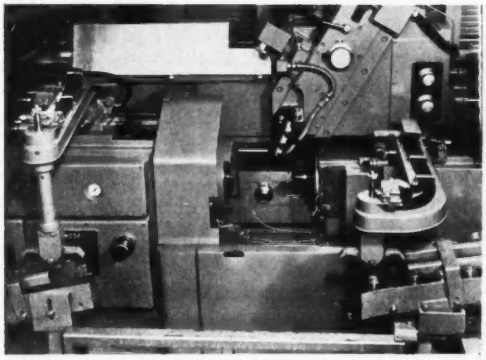
The control equipment (on the lower shelf of the table at the left of the illustration) provides fully automatic centring of the specimen, the actual centring process being observed on the viewing equipment, which consists of a cathode-ray tube, on the screen of which centring performance can be checked. After centring, the error of form can clearly be seen, without the use of the graph recorder. In fact, recording on the polar diagram is in most cases unnecessary and is usually carried out only when a permanent record is required.

Fully Automatic Loading and Unloading Mechanism for Lathes

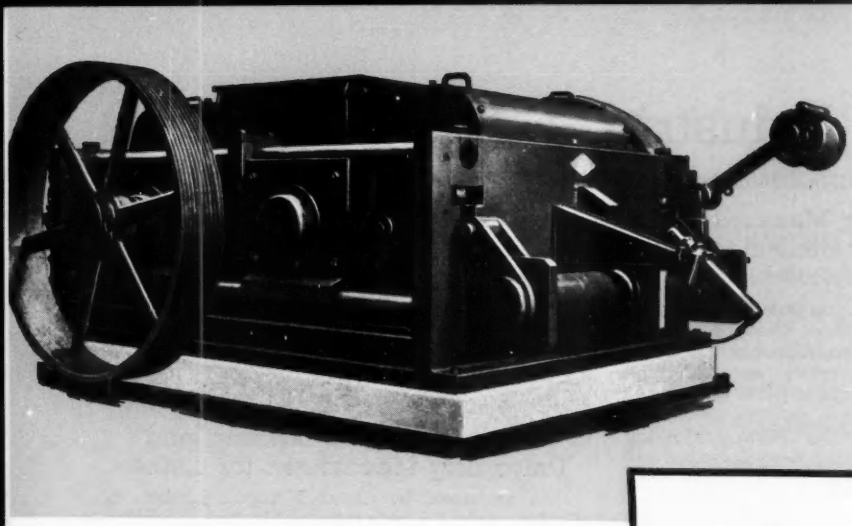
As announced by Churchill-Redman Limited, of Halifax, their P.5 automatic multi-tool and profile-turning lathe is now available with a fully automatic loading and unloading mechanism. The full arrangement also enables the workpiece to be transferred from one machine to another by a conveyor and elevator system. No modifications need be made to the machine to receive the mechanism.

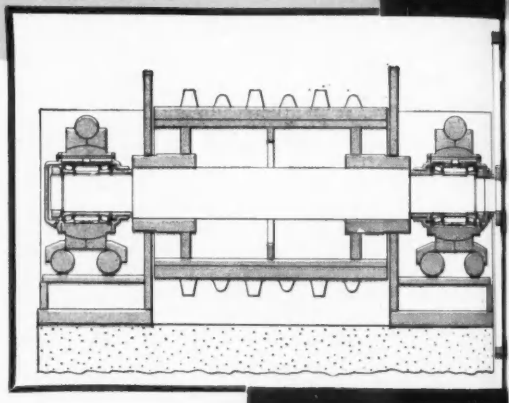
The arrangement consists of two pivoted arms, i.e., a loading arm fixed to the tailstock, and an unloading arm to the top of the headstock. The arms, which are similar, have power-operated gripping fingers at their ends, and each arm is a radius of the arc between the loading or unloading conveyor and the working position of the workpiece. The arms are hydraulically and electrically controlled, and their control system fits in ideally with that of the lathe.

For loading the machine, the fingers grip the component in the input conveyor, the arm swings into the machine, the tailstock advances, moving the component into the open chuck jaws, the 3-jaw compensating chuck closes, the gripping fingers open, and the loading arm returns to the outward position over the conveyor. As the arm is returning, the machine cycle starts. After the



machine has completed its cycle, the unload arm (with fingers open) swings into the machine, the fingers close and grip the component, the tailstock retracts, and the chuck jaws open. The unit then moves to the right, extracting the component from the chuck jaws, after which the arm swings outwards over the unload conveyor and the fingers open to drop the component into the





HEAVY-DUTY
DOUBLE-ROLL
CRUSHER

MADE BY BRITISH JEFFREY-DIAMOND LIMITED

This BJ-D heavy-duty double-roll crusher deals with run-of-mine coal, shale, etc. The largest "feed" size is 42" x 36" x 18", and this is reduced to an 8" product.

There are two roll shafts, one of which is shown in the drawing; each is carried in two pairs of Timken bearings with cup and cone spacers; the bearings on the right-hand side are arranged to allow for end-float, the left-hand bearings control the shaft axially. These bearings are mounted in spherical self-aligning housings and the rolls can be adjusted for product size by sliding the housings along the twin guiding bars on each side, further located by the single guiding bars at the top. These bars can be seen in the photograph, and also the means by which the housing block is traversed in order to control the set of the rolls.

British Timken, Duston, Northampton, Division of The Timken Roller Bearing Company. Timken bearings manufactured in England, Australia, Brazil, Canada, France and U.S.A.

TIMKEN®

REGISTERED TRADE-MARK

tapered roller bearings

conveyor. It then rolls down into an elevator, where it is lifted to run down the input conveyor to the next machine.

The conveyors act as banks, so that each machine can run quite independently of the other. Machine control is provided, however, so that, if the input conveyor is empty or the output conveyor full, the machine will stop. This method gives complete machine flexibility, as it is possible, if required, to isolate the automatic loading and to let the machine be run by an operator in the normal way. The gap between the input and output conveyors gives complete access to the machine, and a safety gate is fitted across this gap, so that, when the gate is opened, the automatic loading equipment is isolated.

The loading and unloading units are extremely versatile and can easily be made to accommodate a wide variety of components. As separate arms are used for loading and unloading, a component which varies considerably in shape before and after machining can also be handled. The unloading-arm gripping fingers can also be made to pivot through 180 deg., so that the component can be placed on the unloading conveyor in the desired position, depending on whether the next machine requires the component to be turned round or whether it is required to be left in the same position.

Shell-Moulding Equipment

Two new items of shell-moulding equipment have been introduced by the Foundry Division of the Electric Resistance Furnace Company Limited, these being respectively the Reynolds shell-moulding machine, which is a manually operated unit for producing good moulds consistently, and the Reynolds shell-mould closing machine for the rapid positive closing of the two halves of a mould. Both machines are simple to operate and can be used by relatively unskilled labour.

The shell-moulding machine has two investment boxes and two heating units for making the two halves of a mould. The boxes are positioned at each end of a steel framework which has at the centre an idling position for the heaters. The framework provides a horizontal track on which the pattern plates, mounted on rollers, can be moved quickly from the heating positions to their investment boxes. The heating units, which are fitted with electric elements providing rapid heating by radiation, are suspended from a rear framework and are easily moved in any direction. The machine illustrated in Fig. 1 shows the two heater units, one in the central idling position, and the other heating a pattern plate ready to be fixed to the open end of the investment box on the right. The left-hand box is shown in the dumping position.

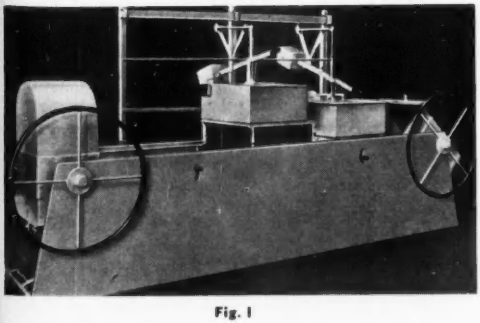


Fig. 1

When a pattern plate has been heated to the required temperature, the heating unit is removed to the idling position and the plate is moved to its investment box, where it is tilted at the correct angle for securing it to the open end of the box with quick-acting clamps. The investment boxes are up-ended with large diameter handwheels to provide the dumping action which compresses the sand to the shape of the pattern. After 8 to 15 sec, depending on the thickness of shell required, the box can be moved back to its original position and the invested pattern plate returned to the track, where it is again covered with a heating unit to complete the curing of the resin-impregnated sand. The shell is finally stripped from the pattern by spring-loaded plungers brought into action with a foot lever. The moulding machine will make shells up to 18 × 14 in., and one operator can produce 25 complete moulds per hour.

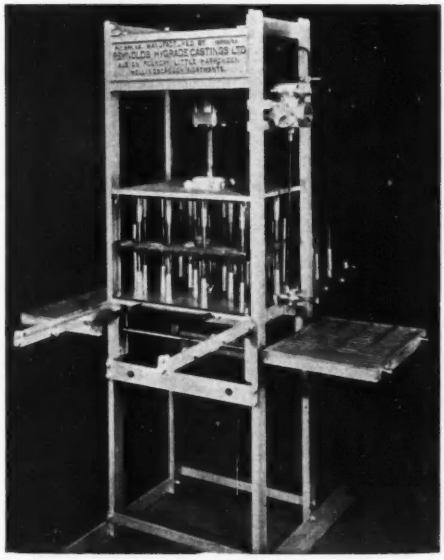


Fig. 2

The shell-mould closing machine is designed for joining with a resin adhesive the two halves of a mould received while still hot from the moulding machine. The shells are placed in one of two loading stations, where they are supported on spring-loaded plungers, after liquid or powdered thermosetting adhesive has been applied to the lower half-mould. The moulds are accurately positioned against stops. The loaded station is moved into the closing press, where a top plate, equipped with a corresponding set of plungers, is raised and lowered by a pneumatic cylinder. The press is closed, and the adhesive sets in a few seconds. The loading stations are used alternately and, as one is moved into the press, it pushes the other to an unloading position. Two side tables are fitted, where the hot shells from the moulding machine can be placed face down until they have passed the thermoplastic stage and can then be supported on the plungers. The machine will accommodate half-moulds up to 6 in. deep, and any reasonable number of plungers may be used. The output of the machine depends upon the setting time of the adhesive, which can be as short as 30 sec. The machine illustrated in Fig. 2 shows a mould being held in the press.

FIFTY

FEET PER MINUTE

Photo printing at greater **practical** speeds

High speed alone is not enough. The design of the machine must enable the operator to make full use of its maximum output. This is where the One-Step III scores over other high speed copiers. It is the successful result of intensive Ozalid research to develop completely new ideas and to produce entirely new photo-copying equipment. The One-Step III will give you real speed—usable speed—continuously.

THE NEW

One Step

MARK III

Your operators can now produce high quality prints at greatly increased speeds because the One-Step III is designed to give maximum assistance.
From the start, its automatic features serve the operator. One switch controls the automatic starting sequence.
It is compact, convenient to use, with simple controls all within easy reach. Automatic separation and development reduce handling when printing and both prints and copies are automatically stacked—below eye level. With a feed width of 44 in. this machine will handle the largest drawings.

- **Combined printing and automatic dry developing at speeds up to 50 ft. per minute.**
- **Automatic separation of original from copying material.**
- **Simple controls, automatic development regulator and constant wattage control.**
- **Filtered air keeps cylinder cool and clean.**
- **Trouble free electronic speed control.**

OZALID

Ozalid Company Limited, Langston Road, Loughton, Essex. *Telephone:* Loughton 5544

Ozalid (Northern) Limited, 16 McPhater Street, Glasgow. *Telephone:* Douglas 7271

Automatic Three-Dimensional Programme-Controlled Milling Machines

As announced by the Rockwell Machine Tool Co., Ltd., of London, N.W.2, the sole selling agents in the U.K., a range of automatic three-dimensional programme-controlled milling machines with table sizes from 43 × 12 in. to 98 × 24 in. has been designed and developed by Fritz Werner A.G., of West Berlin, Germany. These machines, which are available in both horizontal and vertical styles, are standard models with the addition of a special control system, and can, if required, be used as normal machines without any modification. An important feature of the programming equipment is that no tape, wire, or punched cards are used.

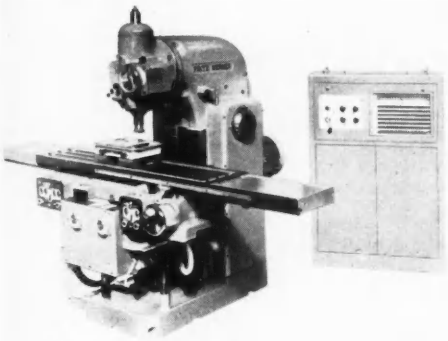


Fig. 1.

Fig. 1 shows a Model FV4 vertical milling machine with a 71 × 17 in. table and a 20-station control cabinet, on the front of which is a main control panel (upper left) incorporating the master switch and selector switches for direction of spindle rotation, coolant suppy, etc. Up to four banks of push-buttons, determining the sequence of the machining programme and enabling a maximum of 80 stages to be covered, can be included in the cabinet, each bank being enclosed by a lockable glazed door. A typical bank is shown at the top right of the cabinet in Fig. 1.

Twenty vertical rows of buttons, with fifteen buttons in each row, compose one bank. The vertical rows are numbered from left to right, as shown in Fig. 2, and the programme stages are carried out in the numbered sequence, the corresponding number being illuminated as each stage is initiated. The function performed at each stage is selected by depressing the appropriate button in the vertical row, an identifying symbol being provided at the end of each horizontal row, as shown in the illustration.

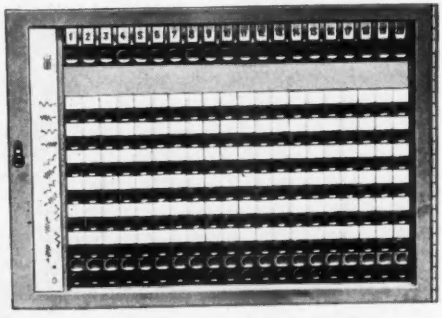


Fig. 2.

Trip dogs on interchangeable carrier-plates secured to the table, saddle, and knee serve to control the lengths of traverses in each direction of motion. The use of these easily stored carrier-plates, together with push-button masking templates, makes these machines equally suitable for small and large batches, as job change-over can be effected in a few minutes.

Direct-Reading System for Data Processing

It is announced by De La Rue Bull Machines Ltd., of London, W.C.1, the Anglo-French company recently formed for the purpose of marketing a complete range of data-processing equipment, that they have made an important advance in the field of direct reading by eliminating the need for transcription of data from a document into perforations on a card and then repeating this operation for checking purposes—hitherto one of the biggest problems confronting manufacturers of such equipment.

The basic principle of the De La Rue Bull direct figure-reading system is that the figures are produced in a magnetic ink which can be printed by any of the accepted printing processes. The figures can also be imprinted by movable type bars, such as those used in adding machines and typewriters, and from embossed plastic or metal printing-plates. Throughout the development of the system, it has been regarded as essential that the figures should be entirely normal in form and instantly readable by the human eye. This important feature has been successfully obtained by printing standard figures in the form of a series of vertical lines, which are spaced either 0·2 mm or 0·4 mm apart, so that the printing of the figure appears virtually continuous to the eye.

The basis of the reading system is that the magnetic ink appearing in the vertical lines is simply an alerting signal to the interpreting equipment, the actual interpretation of the printed figures depending on the relative dispositions of the wide (0·4 mm) and the narrow (0·2 mm) spaces. The normal numerical code is obtained by using seven vertical lines, giving six spaces, of which two are wide and four are narrow. The spaces between different figures are sufficiently great for the reading apparatus to turn itself off, and a quick-acting delay mechanism allows six spaces to be read before the interpreted figure code is transmitted for subsequent data processing or for direct recording. The same principle can readily be applied to the reading of alphabetical information.

The advantage of this system, as compared with the interpretation of thin-line outlines, is that the printed figures are entirely normal, while the advantages, as compared with the reading of magnetic profiles, are that far less accuracy of printing is required because there is an enormous tolerance on the amount of magnetic material appearing in each vertical line, since this acts simply as an alerting signal, and also that, for profile reading, a fairly uniform response must be obtained over the full width of the profile. Furthermore, figures encoded in vertical lines can still be read if the documents are significantly crumpled, damaged, or perforated—

for speed and long life

ECLIPSE 24 TEETH
HIGH SPEED STEEL
USE AN ECLIPSE FRAME

there's

LIPSE 24 TEETH
SPEED STEEL
ECLIPSE FRAME

nothing

ECLIPSE 24 TEETH
HIGH SPEED STEEL
USE AN ECLIPSE FRAME

to beat them

ECLIPSE 24 TEETH
HIGH SPEED STEEL
USE AN ECLIPSE FRAME

Eclipse

HACK SAW BLADES

'Eclipse' hacksaw blades and other tools are made by James Neill & Co. (Sheffield) Ltd. and are obtainable from all tool distributors.

UH37

factors which seriously upset profile reading. The advantages, as compared with systems depending on comparing a printed figure or letter with standard figures or letters already programmed into a memory, are speed, much greater tolerance to damage and misalignment, and far greater simplicity in electronic circuitry, since the signal obtained from the vertical-line coding can be transformed directly into a binary signal.

Betatron for Testing Very Thick Materials

Suitable for the non-destructive testing of very thick materials and also for research with high-energy X-rays and electrons, a 31-MeV betatron, manufactured by Brown Boveri & Co., of Switzerland, is now being marketed in the U.K. by Watson & Sons (Electro-Medical) Limited, of North Wembley, Middlesex.

With this equipment, steel can be radiographed up to a thickness of 20 in. At full output and a focus-to-film distance of 2 metres, it is stated that radiographs of 8 in. of steel can be obtained in 4 min, and in 30 min with 12 in. of steel. The instrument has two focal spots, each 0·1 × 0·3 mm. The wire penetrameter (DIN) sensitivity over a range of thickness between 6 and 14 in. of steel is almost constant at 0·3%, but the very small size of focus permits X-ray magnification to be used, enabling a further improvement in sensitivity to be obtained.

The equipment can also be used for nuclear-physics studies, including photo-nuclear reactions and the generation of Cerenkov radiation, as well as in the study of biological processes induced by high-energy X-rays and electrons. Models producing electrons and X-rays up to 35 MeV are also available for cancer therapy.

A detachable beam equalizer can be used and provides a beam of intensity which is constant to within ±5% over a circle of 20 cm in diameter at a distance of 1 metre from the target. The dose rate, measured with a thimble chamber surrounded by 3 mm of lead, is at least 62 roentgens per minute at a distance of 1 metre. Shutters in each beam control beam height. For setting-up purposes, two light beams are projected along the centres of the X-ray beams. The targets are 531 mm apart and produce X-ray beams which converge to a point at a distance of 2·4 metres and which can be used separately or simultaneously, so that two parts of a specimen can be radiographed with a double field, or stereo-radiographs can be produced.

A control desk contains sequence switches and a delay timer for controlling the magnet field, electron injection, and orbit expansion. Ion chambers are fitted in the betatron head in each beam, and the dose rate and dose are indicated for each on separate meters on the control desk. Exposure can be terminated by the dosemeter (0 to 10,000 roentgens) or a timer (0 to 55 min). Power consumption is 16 kW, and cooling is effected by means of a built-in fan. The basic X-ray head can be rotated by a motor drive about the horizontal and vertical axes and can be mounted on a crane or gantry.

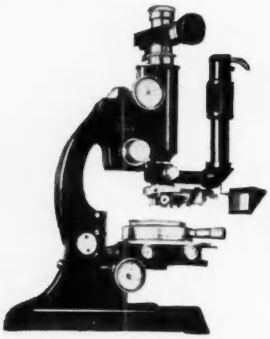
Large Plano-Milling Machine

Designed for machining very large electrical components and steam-turbine casings for the nuclear power industry and now being installed at C. A. Parsons & Co., of Newcastle, a new 450-ton plano-milling machine recently completed at the Manchester works of Kendall & Gent Ltd., one of the group of companies controlled by W. E. Sykes Ltd., of Staines, Middlesex, is the largest ever built in Britain and one of the biggest in the world. The machine (Fig. 1) is 70 ft in length and is capable of handling components up to 35 ft 6 in. long, 12 ft wide, and 9 ft 6 in. high. The table and milling-head traverses are controlled electronically to provide an infinitely variable range of feeds. Additional electronic equipment is fitted to enable the operator to "steer" the cutter by remote control around any workpiece shape, permitting continuous metal removal with a substantial reduction in machining time.

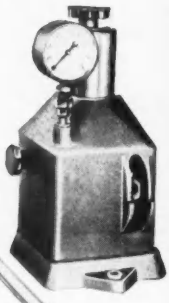
The bed consists of three sections which, when bolted together, weigh 90 tons and have an overall length of 70 ft. The centre bed section houses the table-drive mechanism and also provides the facings for the 40-hp table rapid-traverse motor and the 25-hp variable d.c. feed-traverse motor. The table, which consists of four sections having overall dimensions of 35 ft 6 in. long × 12 ft wide and weighing 64 tons, has been designed to carry a maximum load of 100 tons. The drive to the table is by the Kendall & Gent worm and generated-rack method, two worms transmitting the drive to racks bolted on the underside of the table. Table feeds are infinitely variable between 0 and 50 ipm by electronic control, feeds being selected by means of a graduated dial on each control desk, and the precise feed selected being registered on a tachometer dial.

The two massive columns each weight 43 tons, are 24 ft high, and have a base of 12 ft × 10 ft. The columns are securely bolted and keyed to the centre bed section and are rigidly tied together at the top by an extremely strong box-section cross-stay casting. Thus, a square-frame type of structure of immense strength is obtained, well able to withstand the severest cutting forces from whichever direction they may be imposed. Some idea of the size of the two columns can be seen from Fig. 2, which shows a rear view of the machine.

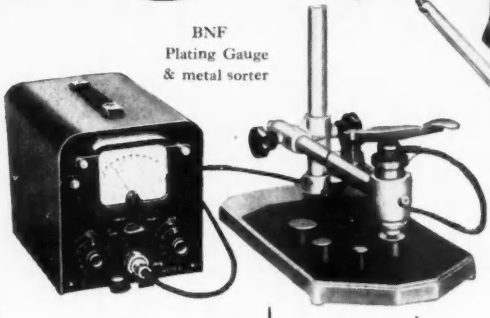
Micro Hardness Tester



Swirl
Electrolytic Polisher



BNF
Plating Gauge
& metal sorter



Specimen
Mounting Press

The most modern range in Metallurgical Instruments

Nash & Thompson make a modern, compact, streamlined range of metallurgical instruments specially designed to meet all your needs, in the laboratory, workshop or industry, accurately, efficiently and economically. The Nash & Thompson high quality equipment gives excellent performance, increases production efficiency and ensures reliable results every time.

For further details write to:

Nash and Thompson LTD

Hook Rise, Tolworth, Surbiton, Surrey.

Tel: ELMbridge 5252

JSP 5691

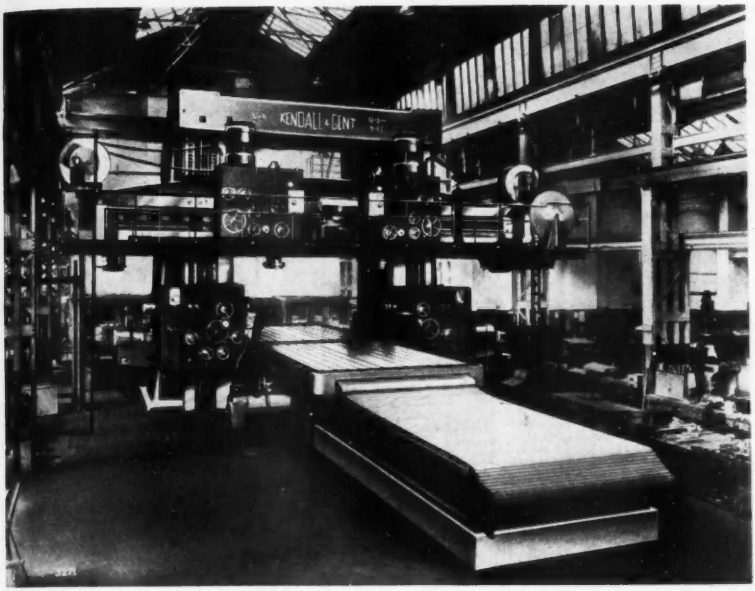


Fig. 1. General view of the new 450-ton plano-milling machine.

The cross-slide casting has an overall length of 45 ft and weighs 40 tons. A deep-section "bow" in the vertical plane, extending the full length of the cross-slide, eliminates the possibility of deflection during cutting operations. In addition to the bow in the vertical plane, a further deep-section bow extends across the rear of the castings between the two columns. When fully erected with the two vertical milling heads, platform, control desk, and other equipment, the cross-slide has a total weight of 86 tons, this weight being partially balanced by counterweights suspended inside each of the columns. The drive for elevating the cross-slide is provided by a 45-hp constant-speed motor which drives an elevating screw, 5½ in. in diameter, housed between the slideways of each column. A compensating device is incorporated in the elevating mechanism so that, if necessary after a long period of wear, the cross-slide alignment to the table can be adjusted. When cutting, the cross-slide is rigidly clamped to each of the columns by locking mechanisms operated remotely by two 1½-hp motors, electrical interlocks with the elevating motor preventing operation of the traverse until the cross-slide is unlocked. Pilot lights are provided on each control station to indicate the condition of the cross-slide locking mechanism.

The machine is provided with four milling heads, i.e., two vertical heads on the cross-slide and two horizontal heads, one on each column. Each head weighs 17 tons and is provided with its own individual 100-hp motor, the drive being through a high-efficiency worm-and-wheel reduction unit to a spindle-speed change-gear box and the final drive to the spindle by means of a large-diameter helical gear. The spindle gearboxes provide 16 changes of spindle speed between 10 and 200 rpm, and gear change is effected by means of a handwheel. The

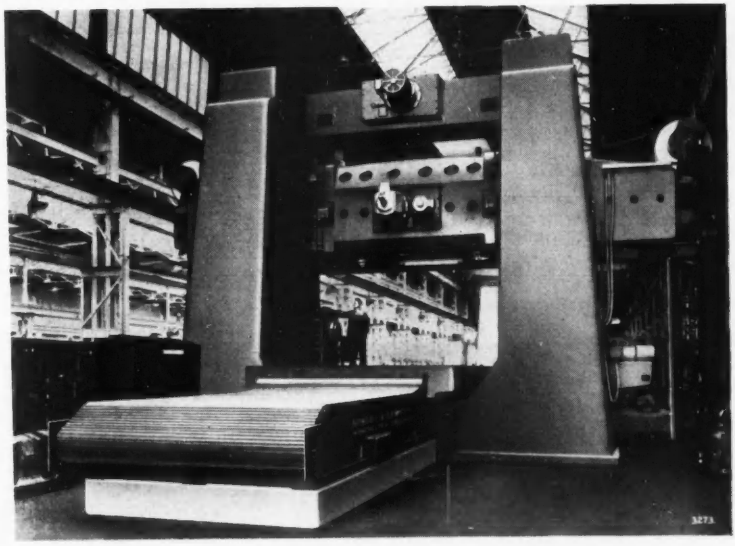


Fig. 2. Rear view of the machine, showing massive columns.

Fischer
FAFNIR

BALL AND ROLLER
BEARINGS

Fischer Bearings Company Ltd: now
becomes Fafnir Bearing Company Ltd.
The manufacture of
FBC bearings continues as before

FAFNIR BEARING COMPANY LTD. WOLVERHAMPTON

REGISTERED
TRADE MARKS
FAFNIR
F.B.C.
FISCHER

F·B·C

cutter spindles are mounted in 15-in. diameter densified cast-iron quills and run in high precision matched bearings. The quills are also provided with a 22-in. diameter flange to facilitate mounting large-diameter face-cutters.

A power traverse of 18 ipm is provided by individual motors to each spindle sleeve; in addition, each spindle can be fine-adjusted by a micrometer dial and handwheel. The combination of rapid traverse and fine feed permits extremely accurate and rapid setting of depth of cut. Hydraulic locking is provided for clamping the spindle sleeves in position and also for locking the milling heads to their slides. The two horizontal milling heads are partially balanced in the same manner as the cross-slide, for ease of adjustment up the column.

The drive for the milling-head feed traverse is by a 15-hp d.c. variable-speed motor which provides infinitely variable feeds between 0 and 50 ipm. Rapid traverse for the milling heads is by means of a separate 20-hp constant-speed motor. Selection of feed or rapid traverse is by push-button from the control stations. Selection of the feed required is from a graduated dial on the control desks, and the precise feed selected is registered on a tachometer dial. Large-diameter handwheels, equipped with micrometer dials, are also provided on each milling head to facilitate fine-setting adjustment.

The traverse drives to the table and milling heads are electronic, varying feed rates being obtained by alteration of the driving-motor speeds. As these motors have to be controlled individually during normal milling operation and also simultaneously when using the steering control, the adjustable-speed drive equipment, supplied by Lancashire Dynamo Electronic Products Ltd., had to be designed to meet both conditions. For control and ease of operation for both normal milling and steering operations, four control desks and two control panels are provided, i.e. a master control desk, a travelling control desk mounted on the cross-slide platform, and control desks for the right-hand and left-hand horizontal milling heads, together with control panels for the right-hand and left-hand vertical milling heads.

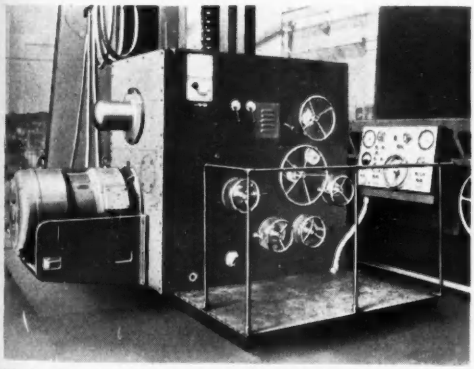


Fig. 3. One of the horizontal milling heads, with control desk.

The master control desk carries controls for operation of the milling head and table rapid traverse and also the cross-slide traverse. The travelling control desk and also the two desks on the horizontal milling heads carry controls for the feed and rapid traverse motions to both table and milling heads. All three of these desks are equipped with steering-control handwheels. Fig. 3 shows one of the two horizontal-milling heads, with its control desk. The two control panels on the vertical milling heads provide controls for rapid and feed traverse of the milling heads. The travelling control desk on the cross-slide platform is equipped with a seat for the operator, and the whole unit is mounted on tracks and provided with a motor drive, enabling the operator to traverse the desk to the most convenient position for operation anywhere along the full length of the cross-slide. The travelling control desk, with its steering-wheel control, can clearly be seen in Fig. 4, which also shows the control panels for the two vertical-milling heads.

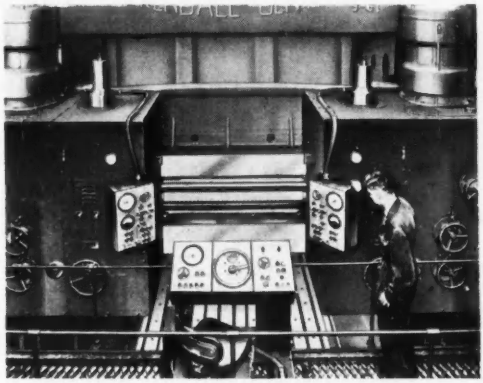


Fig. 4. View of travelling control desk.

The drives for the table and milling head traverses are very similar in arrangement, each utilizing a d.c. drive motor fed from its own generator, each of which is driven by a common a.c. motor in the generator set. This motor also drives an exciter generator which provides the field excitation to the two d.c. drive motors. The output voltage of the two d.c. generators, and hence the armature voltage of the table and milling-head drive motors, are controlled by means of single-phase full-wave thyratron rectifiers feeding the generator field. The field winding of each d.c. generator is designed as a centre-tapped winding, each half-winding being controlled individually by one pair of thyraton rectifiers. As a result, the two drive motors can be operated in either direction without the use of reversing contacts interposed in the armature circuit.

For normal milling operations, the table-traverse motor and milling-head traverse motor operate under separate control systems. On the other hand, when the machine is operating under steering control the table and milling-head traverse motors are simultaneously controlled, allowing the direction of travel of the cutter in relation to the work to be steered through 360 deg.; thus, the cutter can be guided round a complicated shape either in the vertical or horizontal plane, depending on which milling head is selected for operation. Feeds for steering are divided into two ranges, i.e., 1 to 10 ipm and 5 to 50 ipm, selection of the feed range required being made by means of a rotary switch on the control desks. The feed control is a ganged arrangement of potentiometers which provide the correct speed from each motor in order to move the cutter in the direction selected by the steering handwheel. The system is so designed that only one steering handwheel can be in operation at any one time, the desk required for operation being selected from the master control desk. The control circuits for each of the two drive motors remain essentially the same as for the normal milling operation.

This is for the record

A new chart roll is being fitted to the Arkon Recorder. The old one has gone for analysis and comparison. Soon the door will be closed and the pen will make its clear current indication.

Arkon Recorders measure gas and air flow, pressure or vacuum, or pressure and vacuum; flows in one inch pipe or 36 inch mains, pressure or vacuum from 0.1 inches water gauge to 50 lbs. per square inch. They give a clear, unmistakable record which you can read like a book, without hesitation and without mistakes. You can leave the chart on for a few hours, a day, or a week—the record will always be there. Easily read, easy to look after, robust enough to stand on the job, Arkon Instruments can help the control of any process—and their accuracy will satisfy even the men in the lab.

More about them in pamphlet AC/24

WALKER, CROSWELLER & CO. LTD., CHELTENHAM

Telephone: CHELTENHAM 56317

ADDITIONAL ABSTRACTS

Numerous important abstracts which, for lack of space, cannot be published in our main editorial columns are regularly included in condensed form in this section. Subscribers may obtain photostat copies of all original articles at cost.

Some Investigations into Cold-Starting Phenomena in Diesel Engines

By A. E. W. Austen and W. T. Lyn
From a paper presented at a meeting of
The Institution of Mechanical Engineers, London,
December 8, 1959, 17 pages, 19 illustrations

Although the effects of fuel properties on starting and of lubricating-oil properties on cranking speed have been investigated, and certain essentially qualitative general information on the physical aspects of cold-starting phenomena has been obtained, there is a dearth of information on the quantitative correlation of these phenomena with other available data, e.g., on the spontaneous ignition of fuel.

Starting under marginal conditions is influenced in a complex manner by many factors. It was therefore considered advisable to make a somewhat superficial experimental survey of the problem at the outset without going into great detail regarding any particular aspect. This has been done, and it is the purpose of this paper, which is of the nature of an interim report in connection with a long-term research investigation, to present a rough outline of the aspects of cold-starting problems that have so far been studied. Many of the details remain to be filled in, and some major aspects have yet to be explored.

This paper deals with the criteria of ignition under cold-starting conditions and how these criteria may be met by some practical forms of starting aid. From available ignition-delay data and measured compression temperature it has been possible to correlate, in order of magnitude, the variation of starting time with both cranking speed and ambient temperature. The increase in compression temperature and pressure during continuous cranking with fuelling is found to be due partly to sealing action of the injected fuel and partly to the increased compression ratio. The effect of the slow oxidation of the fuel carried over from the previous cycle has been investigated and has been found to be insignificant. From these basic considerations, the effects of engine design and operating variables on cold starting have been discussed.

The principles and limitations of intake-air heating as a starting aid (both by burner and by electrical heating), heater plugs, and heating the injected fuel have been investigated. For the engine used, the lowering of minimum starting temperature is about 20°C (for a fixed cranking speed) when using a burner aid, while a further reduction of 2° to 3°C may be expected if electrical heating is used. It has been found that the main function of a heater plug is to provide a high-temperature ignition source rather than a heat source. The failure of the fuel heating system is due to excessive heat loss before the fuel enters the chamber and to the chamber wall, as a result of impingement when it enters the chamber.

The Welding of Nodular Cast Iron

By R. C. Bates
From *Metal Progress*, U.S.A.,
Vol. 76, No. 5, November 1959,
pp. 95–99, 4 illustrations

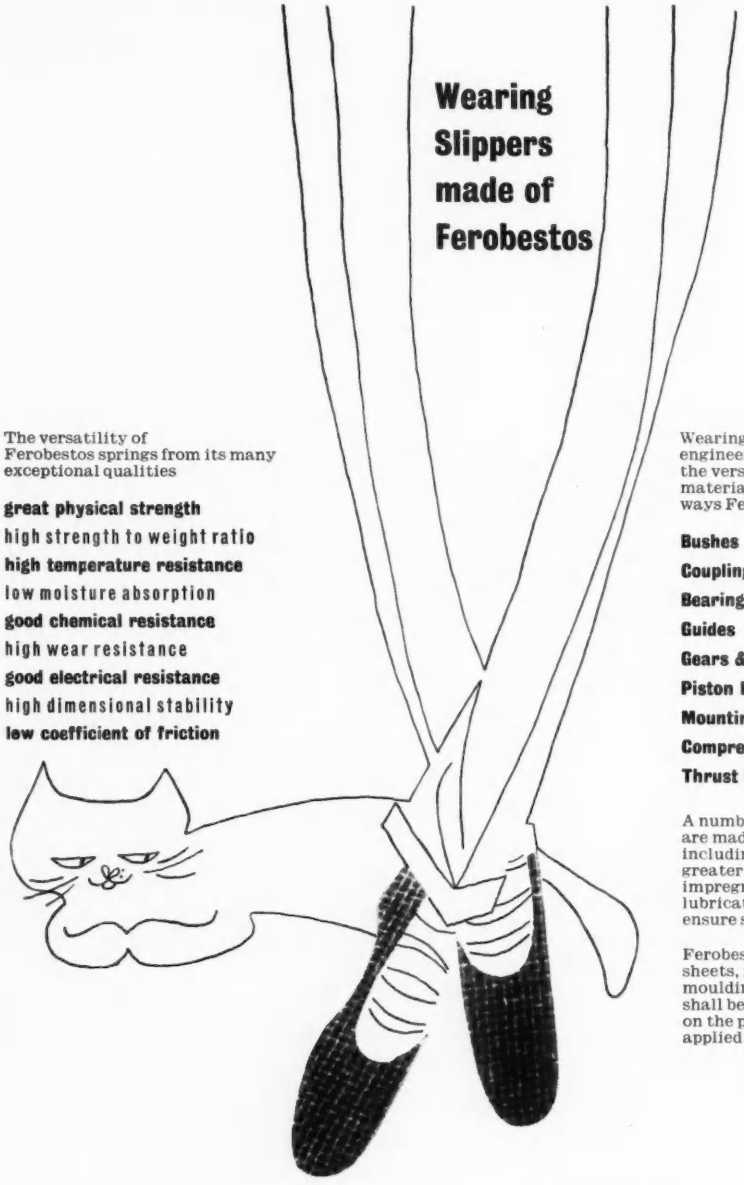
Since its introduction after World War II, nodular iron has become an important material for castings, as its properties and economics are attractive to designers. Unfortunately, many applications have been bypassed, because available welding techniques could not provide joints with properties comparable with those of the parent material. Actually, nodular iron can be welded as easily as grey cast iron, since their microstructures differ primarily in the shape of the graphite particles. However, the welds obtained in both materials are generally fragile, because brittle carbides form in the weld zone. Post-heat treating was reported to be of little value, as the extremely small graphite nodules which form on decomposition of the carbide were believed to reduce ductility.

As described in this article, tests have been carried out in connection with the arc welding and oxyacetylene welding of nodular cast iron, using various types of welding rods. In general, it may be said that arc welds in nodular cast iron contain carbide layers at the fusion lines, lowering ductility and impact properties, though post-weld annealing eliminates these carbides and improves ductility. Oxyacetylene welds are free from carbides but have high transition temperatures.

Like arc welding, oxyacetylene welding produces joints in nodular iron with a strength comparable with that of the base metal. The ductility of oxyacetylene welds is somewhat higher than that of unannealed arc weldments (an average bend of 5 deg. occurred during root bend tests). More significantly, the bending was not confined to the weld metal; instead, bending also occurred across the fusion lines and heat-affected base metal. Thus, the lack of fusion-line carbide allows uniform ductility across the weld zone.

At the present time, while the carbide problem has been eliminated, the problem of high transition temperature remains. This problem must be eliminated before oxyacetylene welding may be recommended for general use in joining nodular iron. Such weldments may be used, however, if the design stress is low enough to ensure that the yield strength is not exceeded (even in the vicinity of stress-raisers), or if adequate inspection can ensure freedom from defects which may act as severe stress-raisers. Oxyacetylene welding may be particularly useful in the future for repairs in non-critical areas where post-weld annealing is not permitted.

Wearing Slippers made of Ferobestos



The versatility of Ferobestos springs from its many exceptional qualities

great physical strength
high strength to weight ratio
high temperature resistance
low moisture absorption
good chemical resistance
high wear resistance
good electrical resistance
high dimensional stability
low coefficient of friction

Wearing slippers is only one of the engineering applications of Ferobestos—the versatile, asbestos-reinforced plastic material. Here are just a few more of the ways Ferobestos can be used:—

Bushes
Coupling Discs
Bearings
Guides
Gears & Rollers
Piston Rings
Mounting Pads
Compressor Blades
Thrust Washers

A number of special grades of Ferobestos are made for particular applications including silicone impregnated for greater heat resistance, and graphite impregnated for more efficient lubrication. Ferobestos gear wheels ensure silence in operation.

Ferobestos can be supplied from stock in sheets, rods, and tubes. Special mouldings can be made to order. We shall be glad to recommend and advise on the possibilities of Ferobestos as applied to any particular industry.

J.W. ROBERTS LTD

Chorley New Road, Horwich, BOLTON, Tel: Horwich 840

Branch Sales Offices: LONDON, GLASGOW, BIRMINGHAM, LEEDS.

A Member of the Turner & Newall Organisation

JWR.20

Investigation into the Onset of Fatigue Damage to Aluminium Alloys from Fretting

By A. J. Fenner and J. E. Field

From a paper presented at a meeting of the *North-East Coast Institution of Engineers and Shipbuilders, Newcastle-upon-Tyne*, January 29, 1960, pp. 184–228, 16 illustrations

Fretting between the faces of metal joints subject to vibration has long been recognized as a possible source of fatigue failure. However, although the problem has received attention from various investigators over a number of years, the basic mechanism of the fretting-fatigue process is little understood, and reductions in fatigue strengths comparable with those sometimes obtained in service have not hitherto been achieved in the laboratory.

This paper describes an investigation into the early stages of fatigue damage produced by fretting in specimens of aluminium alloy B.S. L65. Fretting action was introduced at the surfaces of direct stress fatigue test-pieces of the alloy, by the use of pads of the same material clamped to flat surfaces along the sides of the test-pieces. The relative surface movement between the pad and the testpiece was produced by the alternating strain in the part of the testpiece spanned by the pad. A nominal clamping pressure of 0·25 tsi was employed, and the span of the pads was varied in order to vary the range of fretting movement independently of the fatigue stress in the specimen. The pads were removed at different stages in the various tests, and the state of damage was studied by a subsequent fatigue test or static tensile test of the specimen. Most of the tests were carried out in air, but one series of tests was undertaken with the fretting process applied in a vacuum. Microscopic examinations have been made of some of the fretted surface regions and of sections through them.

It is concluded that, while the fatigue damage due to fretting under a particular set of conditions was fully developed only after about one-fifth of the total life under those conditions, nevertheless significant damage could be developed in a much smaller number of cycles. The mean stress applied to the testpiece during the initial fretting process had an important effect on the rate at which damage was produced. In the very early stages of damage, as revealed by the fatigue tests, no structural changes were detected by microscopic examination of sections through the fretted regions. After fretting for less than 100,000 cycles, however, small cracks could be detected in the sections. These cracks were inclined to the surface, and appeared to owe their origin largely to the local surface stresses. Surface pits were formed at an early stage by the coalescence of some of these cracks.

Fretting-fatigue cracks took longer both to form and to propagate in a vacuum than in air, and the mode of propagation was different. It is concluded that both the initiation of fretting-fatigue cracks and the propagation of cracks through the aluminium alloy are assisted by a process of atmospheric corrosion.

Sealing Characteristics of Stuffing-Box Seals for Rotating Shafts

By D. F. Denny and D. E. Turnbull

From a paper presented at a meeting of *The Institution of Mechanical Engineers, London*, December 2, 1959, 16 pages, 27 illustrations

Although there have been many articles published concerning the best type of packing to use in a stuffing-box and the best methods of inserting the packing and adjusting the gland, the nature of the sealing action of the complete seal has received scant attention. In this paper an attempt is made to analyse the performance characteristics of the stuffing-box, any simplifying assumptions being based on experimental measurement of the properties of the packing material. The analysis is shown to be confirmed by experimental results.

The pattern of stresses set up in the material by the initial tightening of the gland tends to become modified after the shaft has begun to rotate. In the absence of significant fluid pressure this results in the well-known necessity to retighten the gland-bush if leakage is to be kept within acceptable limits. Thus, the characteristics of the seal do not remain constant and it is necessary to relate recorded data to the running time.

The present analysis of the behaviour of stuffing-box seals, based on measured frictional and stress/strain properties of the packing material has shown that two modes of operation exist, according to whether the gland force or the fluid pressure is predominant. With fluid pressures so low that they do not influence the stress distribution set up by tightening of the gland, the behaviour of the seal is controlled entirely by the gland force, friction torque being proportional to the initial gland force, and leakage inversely proportional to the square of gland force. These theoretical findings have been confirmed by experimental observation, but it is found that, during running, the initial stresses tend to be relieved, so that friction falls and leakage rises, the rate at which this happens depending on the type of packing.

Fluid pressure gradients tend to be higher near the gland-bush end of the stuffing-box, especially when the gland is slack, but characteristic friction properties of the packing ensure that, as the gland is tightened, the gradients become more uniform. In the normal working region it can be taken that the various rings of packing are contributing more or less equally to the breakdown of pressure. The same cannot be said of high fluid-pressure conditions, where the pressure drop across the last ring of packing may be over 90% of the total fluid pressure. Under these conditions, the stresses arising from the initial gland tightening soon fall away, and sealing becomes automatic. Thus, torque and leakage characteristics are not a function of running time, as in the low-pressure condition. Friction torque is practically independent of the number of rings of packing and is simply proportional to fluid pressure.

Under all conditions, leakage appears to be independent of shaft speed. Friction tends to be rather high and somewhat variable at low speeds, but levels off at higher speeds to a value that is not much affected by the type of packing.

TERRY'S SPRING PRODUCTS

Whatever you need in springs can be supplied or *made* for you by TERRYS. After more than 100 years of spring making in all its various spheres 'TERRY' & 'SPRINGS' have come to mean the same thing.

QUALITY SPRING WASHERS.

Single Coil No. 159.

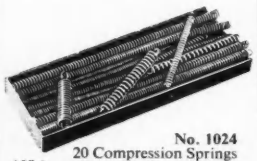
Light Double Coil No. 54A.

Standard Double Coil No. 54.

Hardened and tempered Domed No. 554.

TERRY'S security Worm Drive Hose Clip. Just one example of the kind of thing we make supremely well. Immediate delivery of all sizes from stock. Sample and price list free.

You're sure to find the very spring you want in Terry's Boxes of Assorted Springs



No. 1024
20 Compression Springs 12" long $\frac{1}{4}$" to $\frac{1}{2}$" diam. 24G to 18G suitable for cutting into shorter lengths; and 30 Expansion 1$\frac{1}{4}$" to 12" long. $\frac{5}{16}$" to $\frac{5}{8}$" diam., 22G to 16G. **24/- each.**

No. 757
Extra Light Compression, 1 gross Assorted. $\frac{1}{8}$" to $\frac{7}{16}$" diam. $\frac{1}{2}$" to 2$\frac{1}{2}$" long. 27 to 19 S.W.G. **15/- each.**

No. 761
1 foot lengths Expansion Springs suitable for cutting into shorter lengths. Assorted diameters from $\frac{1}{8}$" to $\frac{1}{4}$" and 24 to 16 S.W.G. **7/6 per box containing 1 dozen lengths.**

No. 1200
Three dozen Assorted Light Expansion Springs, suitable for carburettor control, etc. **13/6.**

No. 760
Three doz. Assorted Light Compression Springs. 1" to 4" long 22 to 18 S.W.G. $\frac{1}{4}$" to $\frac{1}{2}$" diam. **6/6 each.**

No. 762
1 foot lengths Compression Springs suitable for cutting into shorter lengths. Assorted diameters from $\frac{1}{8}$" to $\frac{1}{4}$" and 24 to 16 S.W.G. **4/6 per box containing 1 dozen lengths.**

CUT PRODUCTION COSTS WITH TERRY WIRE CIRCLIPS
We can supply from stock in sizes from $\frac{1}{8}$" to $\frac{5}{8}$".

Interested in Springs? Ninth Edition of "Spring Design & Calculations" post free, 12/6.

Have you a presswork problem? If so, send it along and we'll help to solve it for you.

HERBERT TERRY & SONS LTD

HT23B **Redditch, Worcs.** (*Makers of Quality Springs, Wireform & Presswork for over 100 years*)

Calculation of Roll Force in the Cold-Rolling of Steel Strip

By P. O. STRANDELL
From *Jernkontorets Annaler*, Sweden,
Vol. 143, No. 12, 1959,
pp. 810–889, 52 illustrations

THE factors affecting roll force in the cold-rolling of steel strip are rolling speed, roll diameter, strip thickness, strip width, roll camber, length of the roll face, friction strip-roll, yield strength of the strip, roll material, pass reduction, applied forward and backward tension, rolling temperature, and rolling-mill elasticity. In this paper, these factors are thoroughly examined and analysed in the light of published research papers and experiments by the author. Although the qualitative effect of these factors on the rolling force is known, for numerical calculations further experimental work is necessary for some of them.

Some empirical methods for roll-force calculation are described. These methods are simple in use, as they usually are based on a relatively simple formula and with the reading of a number of roll-force coefficients from a diagram. In many cases, the limit of rollability must be calculated. For the determination of rolling schedules, data are often needed on the maximum reduction for relatively large pass reductions, and in other cases the limit for small reductions. For the estimation of feeding rollers, a determination of maximum pressure with no plastic deformation of the strip is required. Some formulae for the calculation of these limits are discussed. The methods of Sims for calculation of forward slip in cold-rolling, without and with applied tensions, is also discussed.

The roll force has been calculated by some of the methods described in this paper and in a preceding paper, and the results are compared with experimental data in tables and figures. The reliability of the different methods is discussed and recommendations given for the choice of formula for different cases. For careful analysis, the advanced method of Orowan is recommended, and for normal calculations the graphical methods of Bland and Ford and Strandell–Leufven. Ekelund's formula, modified for cold-rolling, gives good correlation if the pass reduction and roll flattening are not too large.

Good correlation is obtained between experimental and calculated data, even for high-carbon and alloyed steels, if the yield strength in compression is used instead of yield strength in tension. For calculations on 18/8 stainless steel, data on yield strength in compression from the experiments of Sims are used, and the results are compared with roll force calculated from stress-strain curves determined from tensile tests. In addition, the effect of elastic deformation of the strip on the rolling force is calculated for one rolling schedule for 18/8 stainless steel.

The Diesel Engine in Association with the Gas Turbine

By E. CHATTERTON
From a paper presented at a meeting of
The Institution of Mechanical Engineers, London,
January 20, 1960, 18 pages, 10 illustrations

THE trend of present practice shows that the further development of the diesel engine is inevitably dependent upon its association with an exhaust-driven gas turbine. In many fields turbo-charging is now almost universal and, as experience is gained, charge pressures are being progressively increased. Any future engine designs must take account of the gas turbine from their inception and will demand the use of charge pressures much higher than can be used when a separate turbo-charger unit is applied to a more or less standard engine designed without reference to its association with a turbine.

In such cases the combination between the diesel engine and the gas turbine to form a power unit can be achieved in different ways, and this paper is a study of the fundamental factors involved in such combinations, with particular reference to three basic systems which have been applied in practice, i.e., (1) turbo-charging, in which the exhaust-driven turbine is mechanically coupled to the compressor, there being no mechanical coupling between the turbo-charger and the engine; (2) compounding, in which the engine, turbine, and compressor are mechanically coupled together through suitable gearing devices; and (3) the gas generator, in which the whole power of the diesel engine is absorbed in driving the compressor, the power output being taken from an exhaust-driven gas turbine which is not mechanically coupled to the engine. The objective of this paper is, therefore, to explore the potentialities of these three systems, taking into account the practical limitations involved.

Potential performances attainable from these three arrangements for both two-cycle and four-cycle engines, with and without charge cooling, are derived by methods which are explained, and it is demonstrated that high specific power outputs become possible at high air-manifold pressures without exceeding established limitations for maximum cylinder pressure, piston temperature, or turbine inlet temperature. The characteristics and limitations of the three alternative arrangements are compared, and the following conclusions are derived:—

(1) The two-cycle engine gives a better response to association with a turbine than the four-cycle engine, particularly at higher manifold pressures.

(2) The simple turbo-charged engine is not suitable for exploitation of the higher degrees of supercharge, owing to the restricted operating speed range obtainable.

(3) The compound engine offers high maximum powers at high manifold pressures, coupled with good thermal efficiencies and a wide speed range, but it suffers from the disadvantage that its power falls off rapidly with reduction in crankshaft speed, unless complexities are introduced in the gearing arrangements between the engine and the compressor.

(4) The gas generator at high manifold pressures produces results comparable with the compound engine and, owing to its free power turbine, can maintain very high torques at low output-shaft speeds.

(5) It would appear that a highly supercharged two-cycle engine used as a gas producer feeding a turbine may provide an efficient and versatile power unit and merits serious consideration.

Do you wait for hot water on a cold Monday morning?

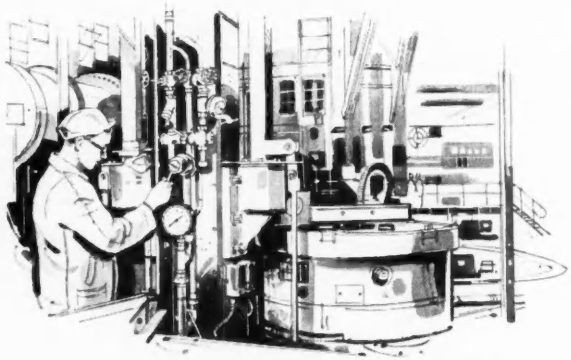
Where hot water is provided from a storage system there is a waiting period when production starts, for the water to heat up in the storage tanks.
With Leonard Steam Water Mixers there is no waiting period. Hot water is available as soon as the steam is turned on.

How would you raise the temperature of a spray very gradually from cold to 120 degrees?

Leonard Valves fitted to the sparge pipe on a cloth scouring and milling machine enable the scourer to vary the temperature to suit the work and to make changes in the temperature during the process gradually, giving a cleaner scour and a better finish.

Do you use cold water when you would like to use hot?

When vegetables are cleaned for canning they are washed in a running stream of water. If the water is too cold the girls' fingers get numb and their production slows down. If it is too hot the vegetables are spoilt. A Leonard Valve looks after the temperature, the girls' fingers and the vegetables.



These are specific examples. Your use of Leonard Thermostatic Steam Water Heaters will probably be different. Write for help. (Our folder H/24)

WALKER CROSWELLER & CO. LTD.

Cheltenham. Telephone 56317

The Use of Ultrasonics for the Non-Destructive Testing of Irradiated Fuel Elements

By J. M. Fouts
From *ASTM Bulletin*, U.S.A.,
No. 242, December, 1959,
pp. 60–62, 4 illustrations

The versatility and usefulness of ultrasonics as a tool for the non-destructive testing of metals has been well established, and many objectionable discontinuities existing in metals, such as cracks, voids, laminations, and porosity, are subject to detection and location by ultrasonic techniques. The method generally utilized is the detection of a distinct echo when sound energy is reflected from a flaw contained in the metal being tested. As described in this paper, an interesting and different method is the use of this pulse-echo principle in the detection of unbonded areas located in the uranium interface or aluminium can-wall interface of irradiated fuel elements.

The underwater equipment for bond testing consists of a manipulator which is placed 10 ft under water and on which a cylindrical slug can be placed on rollers and rotated at 180 rpm. A crystal holder and mount are incorporated into the equipment in such a manner that the slug can be scanned longitudinally while it is rotating at a rate of $\frac{1}{16}$ in. per revolution. Appropriate indicating dials located at the console permit the determination of the exact location of the crystal with respect to the fuel element. High-frequency energy is sent through a water path into the slug for a short-time duration, followed by a pause, and then the echo generated is picked up, this cycle of events being repeated at a convenient rate. The ultrasonic signals are both generated and detected by a single quartz transducer, cut to a disc of $\frac{3}{8}$ in. in diameter and 0·006 in. in thickness for a resonant frequency of 20 Mcs.

It has been established that this ultrasonic method is quite feasible for the non-destructive determination of the extent of unbonded areas between the uranium core and aluminium cladding of fuel elements. Indeed, subsequent sectioning of a number of slugs at areas which the ultrasonic equipment indicated as being unbonded fully confirmed its accuracy.

Solid-State Opto-Electronics

By E. E. Loebner
From *RCA Review*, U.S.A.,
Vol. 20, No. 4, December 1959,
pp. 715–743, 30 illustrations

Solid-state opto-electronics concerns the use and control of numerous relations among optical and electronic phenomena in solids. These phenomena, in which photons and electrons interact with each other in many ways, can be used to generate, convert, and modulate power, or to detect, transmit, process, and display signals.

The simplest class of opto-electronic devices consists of converters, one of the earliest opto-electronic converters being the photovoltaic cell. Previously only a qualitative detector of radiation, this device promises to become quite useful in the conversion of solar power. Very recently, new photovoltaic effects, which might extend the utility of photovoltaic converters, have been discovered in disordered crystals.

An electroluminescent cell is not only formally, but also operationally, the conjugate of the photovoltaic converter, and an interchange of the input and output power is possible on the very same device. Both devices incorporate a solid-state structure known to be characteristic of rectifiers. The electroluminescent converter is undergoing a development in two areas, i.e., as a radiant power source and as an electric-to-radiant signal transducer. In the former case, improvements of its operating characteristics, i.e., efficiency, output level, and life expectancy, are being sought; in the latter case, new applications in controls, automation, instrumentation, and displays are being found.

A more complex class of opto-electronic devices consists of modulators. Many of these are capable of power gain and quantum yield greater than unity. Photoconductor devices are the oldest and best known of the various modulators, the passage of current through them being modulated by the amount and spectral composition of incident radiation. Devices in which the radiation modulates electroluminescent power conversion have been called photo-electroluminescent devices, while devices with electrical modulation of a photon-to-photon conversion process have been referred to as electrophotoluminescent. Electrical modulation of electrofluorescent power conversion has also been reported in germanium. Thus far, only the photoconductor has achieved industrial prominence.

The third level of complexity is attained by an electrical association between an electroluminescent cell and some modulator such as a photoconductor, transfluxor, or transpolarizer, and the arraying of these cells into large-area display panels. Such panel devices are potential contenders for the place of the so-far dominant cathode-ray tubes in special large-area applications. Many problems remain unsolved, although many image-intensifying, converting, storing, and reproducing panel devices have been built.

A fourth level of complexity is found in opto-electronic logic nets and computer components, which, in spite of their present sluggishness, offer the advantages of small size, weight, power consumption, and cost. Parallel and series electrical and optical associations of conjugate opto-electronic transducers are used to design image-processing panels such as planar shift registers, logic matrices, and code converters.

The highest level of complexity is exemplified by opto-electronic devices of the future, which may consist of many-layered optically coupled stacks of the planar devices mentioned above. Alpha-numerical character encoding and decoding devices or picture-analysing and abstracting data-handling equipment are some of the possible future applications of solid-state opto-electronics. The logic organization of such devices will most likely tend to resemble more and more that of biological neural networks. Logic flexibility can be incorporated into opto-electronic networks using the threshold of photo-responsivity.

Things looking up?

Business grows. Add a new machine. And grows and grows. Add a couple more. Sounds simple—till you start wondering where the money's coming from. That's where UDT comes in. UDT helps you replace old equipment, add new, out of income. Which often means it pays for itself out of increased profits. A nice businesslike way to do business. If you think UDT could help you, get in touch with the Manager of your nearest UDT office—the address is in your local directory.

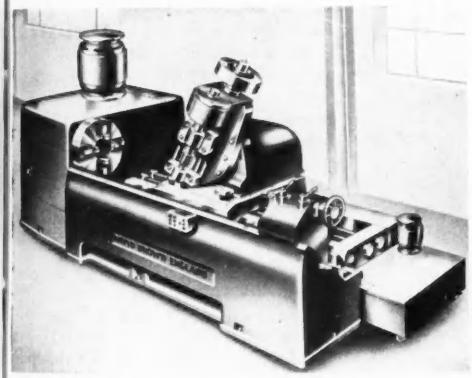
United Dominions Trust (Commercial) Limited

United Dominions House Eastcheap, London EC3

New Materials, Processes, and Equipment

Precision Pinion-Hobbing Machine

The latest addition to the David Brown range of gear-hobbing machines is their new P12H precision pinion hobber, which is built by the David Brown Machine Tool Division, of Manchester, and is designed for hobbing double-helical pinions up to 12 in. in diameter, with an overall face-width up to 30 in. and an overall shaft length of 80 in. Apart from the wide range of pinions it is capable of producing economically, the P12H machine, which is considerably smaller than the turbine pinion machines in current use, greatly simplifies the problem of floor space, and incorporates all essential features for the production of high-precision gears.



Permanently mounted measuring equipment is incorporated, and accurately ground dividing plates are provided for mounting on adaptors on the dividing worm and leadscrew, and also on the hob arbor for checking uniformity of motion between the hob and work-spindle and on the dividing worm and work-spindle. The work spindle, to which the dividing wormwheel is attached, is supported radially and axially on generously proportioned bearings, the diameters and faces of which are precision-ground and lapped. The 20-in. diameter dividing wormwheel has 150 teeth with a low pressure angle, ensuring the maximum number of teeth in simultaneous contact with the dividing worm. The teeth are cut in position on the work spindle on a specially designed master wormwheel generator.

The 4-in. diameter leadscrew is mounted near the locating Vee guide of the hob saddle and is of exceptional accuracy, a certificate of accuracy being supplied with every leadscrew. Axial location of the screw is by means of case-hardened, ground and lapped, flat thrust-washers located at one end of the screw. The nut assembly, which is mounted on the hob slide, comprises two separate nuts widely spaced, one of which is permanently mounted, and the other arranged so that it can be rotated by means of the worm and wheel provided relative to the fixed nut and thus eliminate backlash.

The design of the differential gear has received particular study to eliminate the errors which could arise from this unit and comprises case-hardened and profile-ground spur gears mounted on ball bearings. A motor-operated rapid traverse for the hob saddle is provided for use when setting up, together with limit switches at extreme positions to prevent overrun. In addition to the tailstock for supporting the work, two additional work-steadies are supplied, and the sizes of these can be varied to suit users' requirements. Automatic lubrication is provided for all gears and bearings, the circulation pump being motor-driven and electrically interlocked with the main motor to prevent the machine from being started until the oil is in full circulation.

Twin-Spindle Automatic High-Speed Grinding Machine

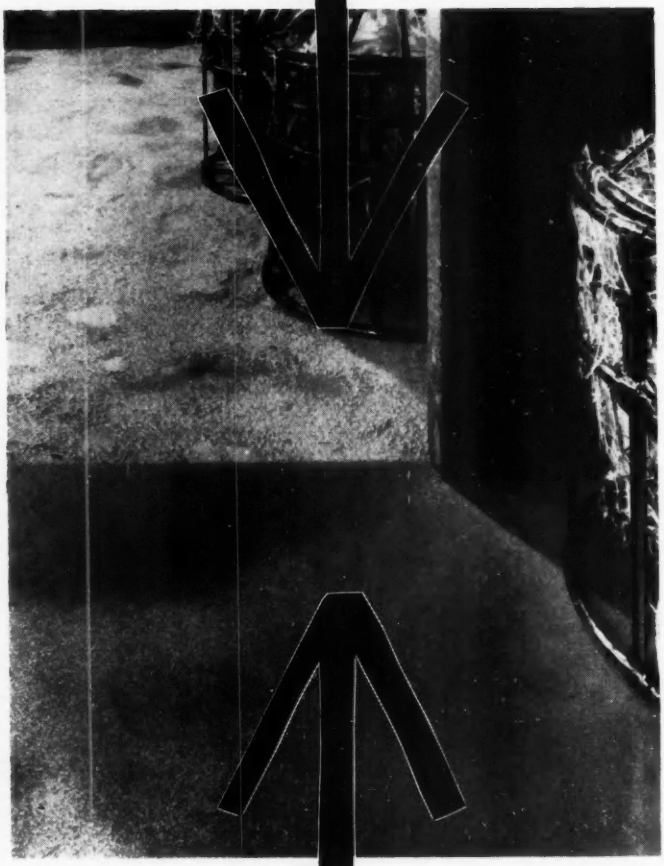
A new twin-spindle automatic high-speed grinder recently developed by the Michigan Tool Company, of Detroit, Mich., is designed for the simultaneous deburring and chamfering of the entire contour of both ends of the teeth on spur, helical, or bevel gears. The standard machine will handle gears from 3 to 13 in. o.d., but other models of the same type, suitable for gears up to 20 in. o.d., are also available.

The machine (Fig. 1) utilizes reinforced air-driven grinding wheels operating at 17,000 rpm, using shop air pressure regulated at the machine. Grinding-wheel diameters range from $1\frac{3}{4}$ to 3 in., depending on gear size, and,

Fig. 1.

NEW

EPOXY FLOORING RESISTS CHEMICALS



Solve your flooring problems with epoxy-resin-based Ceradek, the screeded surfacing which is resistant to a wide range of chemicals. Dry or wet, a safe non-slip surface. No dust hazards and laid in continuous, unbroken surfaces with great resilience and high impact strength. Light in weight. Available in four colours. Withstands heavy traffic after laying, and bonds tenaciously to various surfaces (old or new concrete, etc.)

Many times stronger than concrete, Ceradek is the complete, protective surfacing which offers large scale economies and hard-wearing, long life. It is suitable for an almost unlimited number of industrial applications. Our technical staff will gladly advise you on all aspects of Ceradek installation. Please write for further details, specific recommendations and quotations as required.

Concreted factory floor after three months' wear showing untreated and Ceradek treated surfaces

WITH **Ceradek**

Epoxy
SCREEDED FLOORING

laid only by:—
TECHNICAL APPLICATIONS LTD.
VALLEY WORKS - MONTON ROAD,
ECCLES - LANCASHIRE
Eccles 1737

to equalize wear on both sides of the wheels, they are interchanged on the spindles after every four hours. Air clamping is provided, where necessary. Gear rotation is accomplished by means of a fractional-horsepower electric motor.

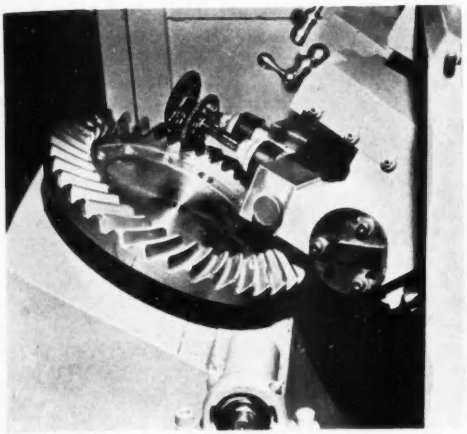


Fig. 2.

In operation, all that is necessary is to start up the grinding-wheel spindles, place the gear on the fixture, and press two buttons to initiate the machine cycle. The fixture starts rotating and tilts upwards, the grinding wheels lower to contact the work, and operations commence. The grinding wheels are protected by the head during loading and do not provide any safety hazard. After a preset number of rotations of the gear, during which the grinding wheels rise and fall to follow the contour of the heel and toe, the spindles are raised, the fixture is lowered to the unload position, and rotation of the fixture is halted, the entire operation being performed automatically.

The number of rotations of the gear is determined by the depth of chamfer desired. The cycle time is set on a timer and is determined by the number of rotations required, the pitch of the gear, and its size, varying between 20 and 60 sec per gear. Gear-rotation speed is selectively adjustable, and counterweights incorporated in the spindles can be adjusted to vary grinding pressure on the work. The wheel spindles are also fully adjustable to position the grinding wheels for different sizes of gears. The operator is shielded by a protective hood, but can view the process through a window in the hood, which also incorporates an exhaust outlet for connecting to a dust collector. Fig. 2 shows the wheels in the working position, with the protective hood raised.

Continuously Recording Gamma-Radiation Monitor

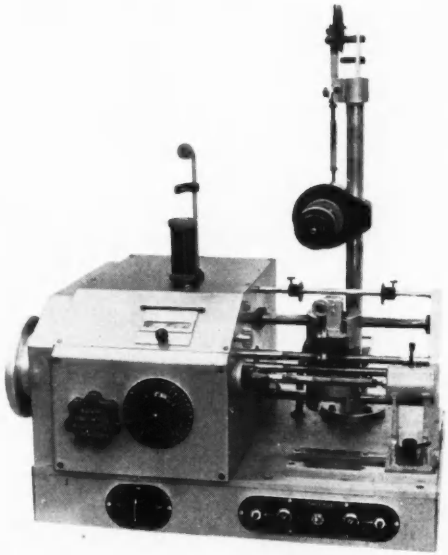
Measuring 9 in. in diameter and 30 in. in height, the Model 65A "Gammagraph", developed and manufactured by Electronic Instruments, Ltd., of Richmond, Surrey, is designed to make accurate measurements of gamma radiation both indoors and outdoors. These measurements are continuously recorded, so that the radioactive fall-out or any rise in background radiation, such as may occur in the vicinity of a nuclear power station, can easily and immediately be discovered.

In essence, the Gammagraph is a ruggedly constructed recording radiation dose-rate meter, in which three preset ranges enable accurate records to be kept of gamma-radiation levels from natural background level up to 10 milliroentgens per hour, sensitivity being nearly quality-independent from 60 keV up to 2 MeV. The equipment basically comprises an ionization chamber, 18 in. in length, containing a special mixture of gases under pressure and mounted vertically on a hermetically sealed case which incorporates electrometer circuits and a clockwork-driven recorder. The recorder trace can be observed through a glass panel, and all controls are mounted internally to avoid unauthorized interference. The equipment, which weighs about 70 lb, is completely mobile, power for one month's continuous operation being derived from a conventional 12-V, 40-Ah car-battery. Except for one electrometer valve, the circuit is fully transistorized.

Zero stability is better than 2% of full scale on any range during the month of operation, and is largely independent of battery voltage and ambient temperature. The transistorized electrometer used is of new design and is capable of driving a 1-mA recorder to full scale with currents as low as 10^{-12}A. Linearity and stability are assured by high overall feedback, but the power consumption of the complete instrument is less than 0·5 W.

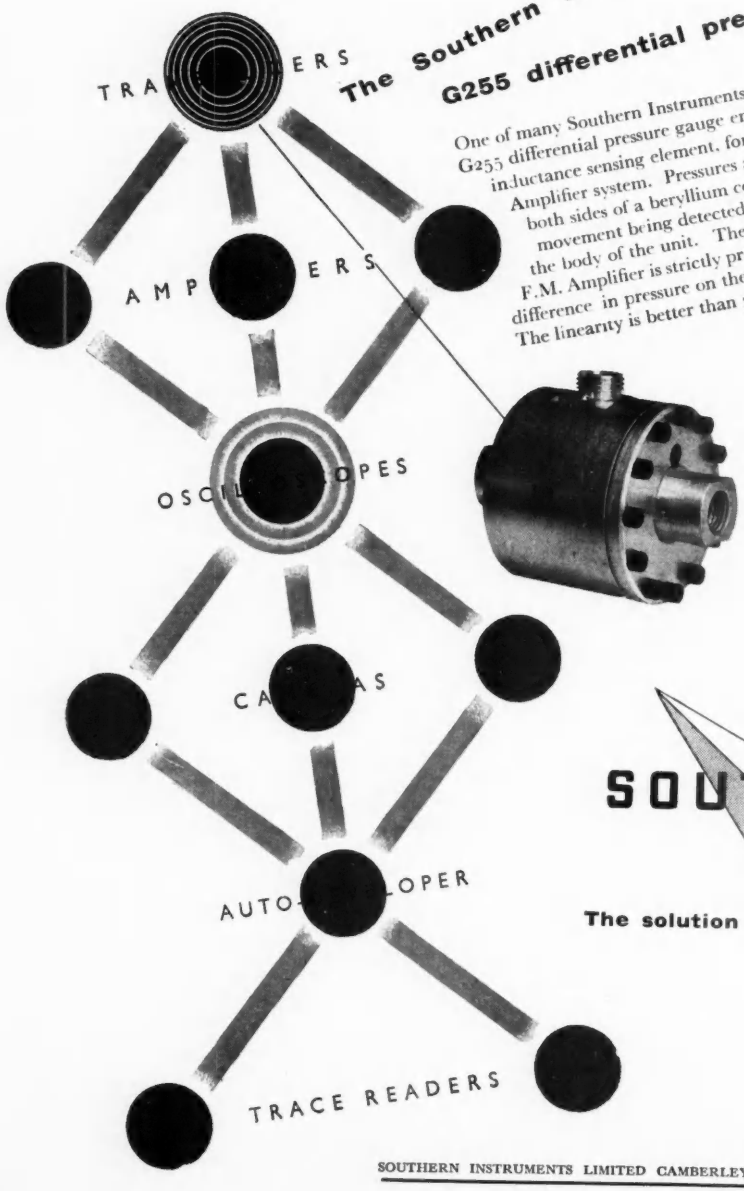
Bench-Type Coil-Winding Machine

Occupying an area of only 24 in. square, a new bench-type coil-winding machine, manufactured by Westool Ltd., of St. Helen's Auckland, Co. Durham, is capable of winding coils of up to 5 in. in diameter and 3 in. in length in gauges from 30 to 50 s.w.g. The reel-carrier spindle is suitable for reels up to 6 in. in diameter but, for winding fine gauges from 47 to 50 s.w.g., a small "over-end" feed is also supplied.



The machine, which is complete with meter and drive, is fitted with a five-figure reset revolution counter and

The Southern Instruments system



G255 differential pressure gauge

One of many Southern Instruments transducers, the type G255 differential pressure gauge employs a variable inductance sensing element, for use with their F.M. Amplifier system. Pressures are applied to either or both sides of a beryllium copper diaphragm; movement being detected by an inductor cast into the body of the unit. The voltage output from the F.M. Amplifier is strictly proportional to the difference in pressure on the side of the diaphragm. The linearity is better than 3% of rated range.

SOUTHERN *Instruments*

The solution to your problems

SOUTHERN INSTRUMENTS LIMITED CAMBERLEY SURREY. CAMBERLEY 3401

can be designed for any value of maximum speed up to 4000 rpm. The rate of acceleration from zero to maximum speed is determined by means of a handwheel on the front of the machine, this handwheel operating a potentiometer which controls an electric clutch coupled to the motor. The traversing mechanism incorporates two electric brakes coupled to two wormwheels in constant mesh with two leadscrews. The traverse is set by adjustable stops which actuate microswitches, energizing and de-energizing the brakes and giving positive and instantaneous reversal of direction. The wire spacing (turns per inch) is set by means of a handwheel moving against a scale calibrated in standard wire-gauge sizes or in decimals of an inch.

Portable High-Power Industrial X-Ray Unit

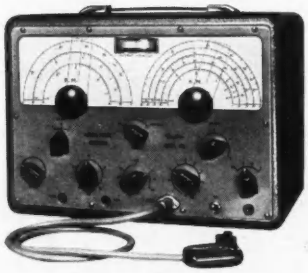
A new portable industrial X-ray unit with high penetrating power and excellent radiographic definition, announced by Philips Electronic Instruments, of Mount Vernon, New York, is completely self-contained and is shockproofed, rayproofed, and weatherproofed for outdoor operation. Designated the Norelco PG 300, the new unit has an oil-insulated tube-head, $9\frac{3}{8}$ in. in diameter and $47\frac{5}{8}$ in. in length, including handles. The tube-head weighs only 231 lb, so that it can be hoisted to remote areas for the radiography of more than 3 in. of steel. The control cabinet measures $19 \times 12\frac{5}{8} \times 11\frac{1}{4}$ in. and weighs 77 lb.

The emergent beam angle is 40 deg., and the focal-spot size is 2·3 mm. X-ray voltage is continuously adjustable under load from 65 to 300 kV, the load rating being 5 mA up to 260 kV and 4 mA from 260 to 300 kV. An intermittent duty cycle is permitted with air cooling, but can be 100% continuous with water cooling. Safety devices effectively prevent overload of the tube, and an automatic reset timer is included with the control unit.

Signal Generator with Sweep and Crystal Calibrator

Mainly intended for servicing A.M. and F.M. high-frequency radio receivers and the intercarrier I.F. stages of television receivers, the new Model 61A signal generator with sweep and crystal calibrator announced by Taylor Electrical Instruments Ltd., of Slough, Bucks., provides, in conjunction with an oscilloscope, complete facilities for the sweep alignment of the R.F., I.F., and discriminator or ratio detector stages of A.M. and F.M. receivers.

The A.M. generator covers the range between 4 and 120 Mcps in five bands, all on fundamentals, the calibration accuracy being $\pm 1\%$, and the modulation 35% at 400 cps. The F.M. and sweep sections also operate on fundamentals, avoiding the confusion and poor frequency accuracy inherent in the frequency-difference method. The F.M. and sweep bands cover frequencies from 4 to 12 Mcps and 70 to 120 Mcps in three bands, the calibration accuracy of the F.M. generator being $\pm 2\%$. The A.M. generator can be used as a marker during sweep alignment, and a variable phasing network and retracing blankets are provided.



Deviation on F.M. is variable up to 100 kcps from the mean carrier frequency at a modulation rate of 400 cps. The sweep covers a total band width of 1 Mcps at power-line frequency. A crystal calibrator circuit, with switch selection of any one of three internally mounted crystals, is incorporated, and crystals in the frequency range between 1 and 11 Mcps can be supplied.

The new generator provides a very wide range of facilities, all of which can be selected by internal switching, no external cross-connections being necessary. When using the sweep facilities, the marker level can be continuously varied. An added facility for servicing audio stages is provided by a variable-level 400-cps signal. A five-section attenuator with a non-inductive potentiometer ensures accurate attenuation over the entire frequency range, while R.F. leakage has been reduced to a minimum by careful shielding of the attenuator and oscillator sections.

Bench-Mounted Air-Operated Grinder

A new air-operated grinder for mounting on work benches has been introduced by the Consolidated Pneumatic Tool Company Ltd., London, S.W.6. The new grinder, known as the 3190M, has a wheel of 6 in. diameter and 1 in. width, the free operating speed being 4,500 rpm. The total height of the unit is $9\frac{1}{16}$ in., and its weight, including the guard, is 12 lb.

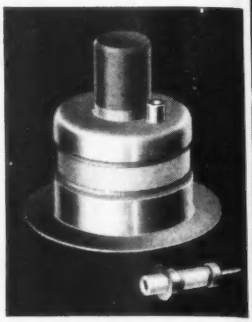
Power for the tool is developed by a vane-type motor, a particular feature of which is a constant-speed governor which maintains the wheel at the most efficient cutting speed from no load to full load and eliminates the possibility of overspeed when running free. In addition, a heavy valve spring and loose fitting valve which prevents the valve from being jammed by foreign matter, and a neoprene " O " ring which gives a leakproof valve seal are incorporated.

INSULATION AND STRENGTH

material answer to design problems

Sintox—an alumina ceramic of exceptional insulation characteristics—is superior in tension, compression and cross-breaking. In small assemblies it can be an insulator *and a* structural support.

Sintox also stands elevated temperatures with little change in its properties, has high thermal conductivity and superior corrosion resistance and —for nuclear application—low neutron capture cross-section.



BRAZED METAL/CERAMIC TERMINAL SEALS

These seals are brazed vacuum-tight assemblies capable of withstanding elevated temperatures and pressures under conditions of continuous operation.

Sintox Technical Advisory Service

This service is freely available without obligation to those requiring technical advice on the application of Sintox Industrial Ceramics. Please write for booklet or any information required enclosing blue print if available.

SINTOX

engineering ceramics

We are exhibiting at the Engineering Materials and Design Exhibition, Earls Court, Feb. 22-26, Stand 108.

S.2. SINTOX IS MANUFACTURED BY **LODGE PLUGS LTD., RUGBY**

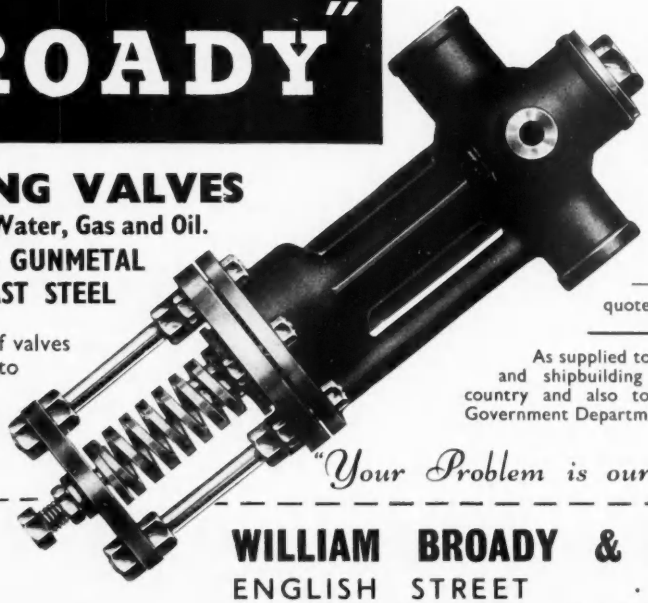
"BROADY"

REDUCING VALVES

For Steam, Air, Water, Gas and Oil.

***Manufactured in:* GUNMETAL CAST IRON CAST STEEL**

A wide selection of valves for pressures up to 6000 lbs/sq. in.



. . . Although there is no better reducing valve than a BROADY—every reducing valve should have a Relief Valve—and we manufacture Relief Valves which are in every way, comparable to our Reducing Valves —so please ask us to quote for both.

As supplied to the largest industrial and shipbuilding Companies in this country and also to the Admiralty and Government Departments.

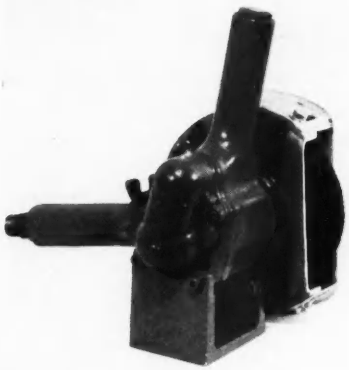
"Your Problem is our Challenge"

**Also for dealing with Superheat conditions.*

WILLIAM BROADY & SON LTD.

ENGLISH STREET · HULL

Grams: Broady, Hull. Telephone: Hull Central 29894 (5 Lines)

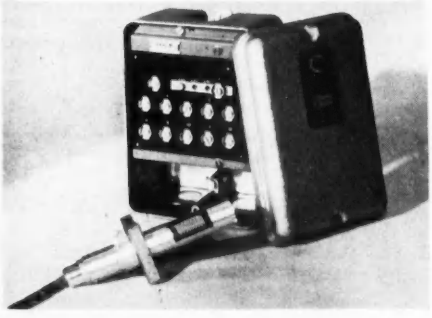


Whilst the drilled baseplate on which the grinder is mounted makes it particularly suitable for attaching to portable compressors for the maintenance of tools, such as the touching up of drill steels, breaker points, etc., it should also find a wide general application where occasional bench grinding tasks exist and where a supply of compressed air is available.

Photo-Electric Oil-Burner Control

Designed for the automatic operation of small oil burners with a consumption of up to 4 gph, the new "Satchwell" type-DG oil-burner control announced by The Rheostatic Company, Ltd., of Slough, Bucks., utilizes an extremely simple circuit arrangement, without the need for thermionic valves or an amplifier. In addition, the small size of the control box makes it specially suitable for incorporation into small oil burners. The control, working in conjunction with a photo-sensitive cell, provides fully automatic operation of burners in response to their controlling thermostats and ensures a rapid shut-down in the event of flame failure.

As soon as the controlling thermostats call for heat, the control relay closes, energizing the ignition transformer. Approximately 15 seconds later, the burner motor is started. If the flame is established, the photo-cell is illuminated, and the relay switches off the ignition, but the motor circuit is maintained, and the burner continues to operate until the controlling thermostats function. If the oil does not ignite on starting, the photo-cell will not be illuminated, and a thermal lock-out timer switches off the burner motor within approximately 17 sec. The burner cannot be started again until the lock-out switch is reset manually by depression of a push-button in the control-box lid. Terminals are provided, so that an external alarm or signal can be connected to indicate that lock-out has occurred.



If the flame fails during a run, ignition is re-established but, if the flame is not re-ignited, the control locks out in approximately 10 sec. No purge period if provided, as the ignition circuit is re-established immediately the flame fails. In the event of an electricity supply failure, the burner is stopped and, on resumption of supply, the normal starting sequence automatically takes place. The control is so designed that, in the event of abnormally low supply voltage, safe operation is always ensured. Also, if the photo-cell head is removed from its mounting for cleaning, ambient light falling on the cell will not allow the burner to start.

Miniature A.C. Hysteresis Motors

Believed to be the most powerful a.c. motor of its size in existence, the new Size 11 hysteresis motor announced by Smith's Aviation Division weighs only 4¼ oz., and has a mechanical output of no less than 8 W for an outside diameter of 1 1/8 in. and a body length of just over 1½ in. The motor, which has the advantages of completely synchronous operation and the ability to start under full load, is basically a three-phase, four-pole type for use on 400-cps supplies at either 200 V when star-connected, or 115 V when delta-connected. However, a 50-cps version is under development. Possible applications for these motors include their use in blowers for electronic equipment, in drives for programme units in missiles and computers, in speed servos, and in tape-mechanism drives, e.g., in airborne tape-recorders.

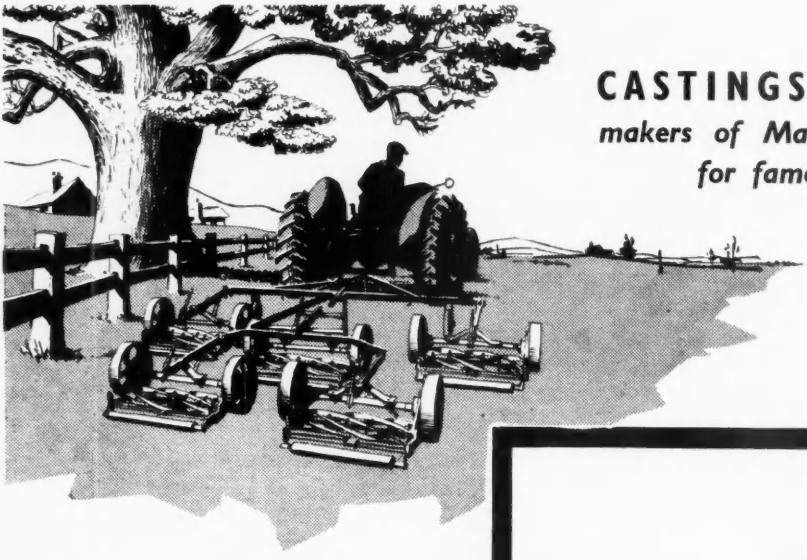
When operating on 200-V, 400-cps current, these motors have a synchronous speed of 12,000 rpm, a maximum synchronous torque of 60 gm-cm, a maximum synchronous torque current of 102 mA, a mechanical output of 8 W, and an efficiency of 50%. It should be noted, however, that, in addition to these three-phase four-pole motors, a two-phase six-pole version is also available. In this case, the synchronous speed is 8000 rpm, the maximum synchronous torque is 35 gm-cm, the maximum synchronous torque current is 115 mA, the mechanical output is 3 W, and the efficiency is 35%.

The Suitability of Various Gases as Working Media for a Nuclear Reactor-Gas Turbine Combination

(*Concluded from page 95*)

well suited because of its rather unsatisfactory properties under irradiation. Of the remaining two gases, helium should be preferable to carbon dioxide, despite its high cost, which must, in any case, be offset to some extent against the additional cost of the beryllium or beryllium oxide moderator required in the case of carbon dioxide. Moreover, carbon dioxide, as already mentioned, is not suitable for use with many steels at high temperatures.

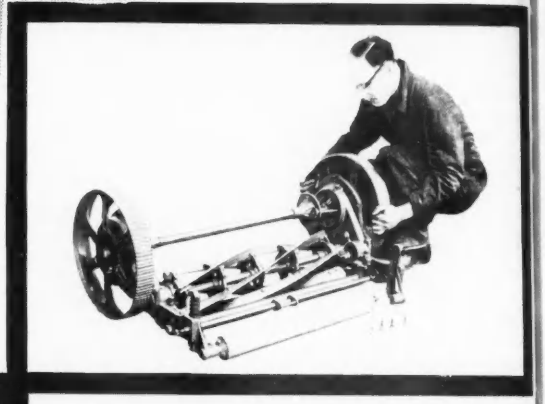
To sum up, then, it is considered that, notwithstanding its high cost, helium is the best gaseous medium for use in a closed circuit comprising a nuclear reactor and a gas turbine.

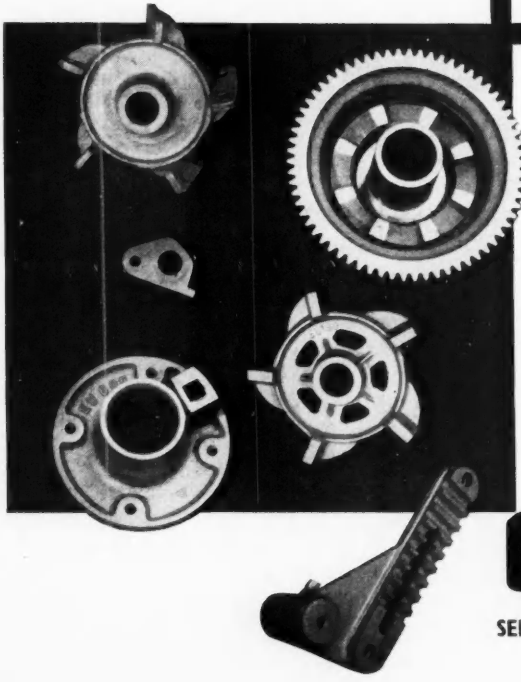


CASTINGS LIMITED

makers of Malleable Castings for famous firms

SPEEDING PRODUCTION OF LLOYDS & CO., NEW "LEDA" GANG MOWERS





Lloyds & Co. (Letchworth) Ltd. write: "The fact that we are now able to commence production of our new "Leda" Gang Mowers is largely due to the assistance and co-operation we have received from you during the development of these machines." We are proud of this testimonial to the service we offer all our customers.

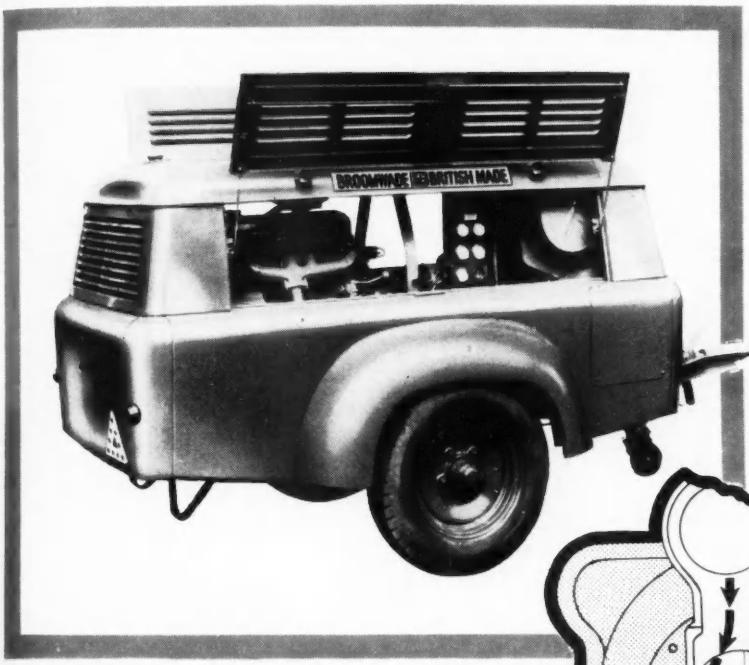
Our two foundries produce jobbing and repetition Malleable Castings up to 70 lb. in weight. Of especial interest are our Blackheart castings, which remain tough and ductile at sub-zero temperatures; our Pearlitic castings, of exceptional strength and toughness; and our Weldable Malleable castings which can be combined into composite fabrications with other materials. Write for full particulars today.

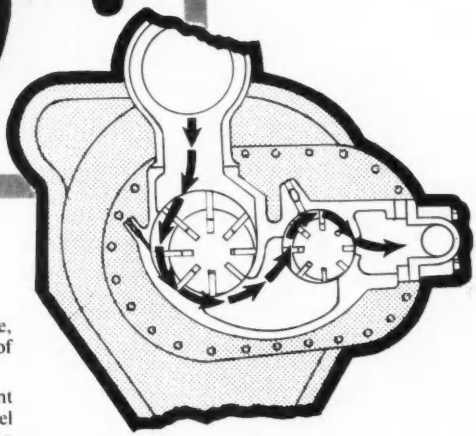
CASTINGS LIMITED

FOUNDED 1835

SELBORNE ST., WALSALL, STAFFS. Tel: Walsall 3118-9
and at LICHFIELD ROAD, BROWNHILLS, STAFFS.
Tel: Brownhills 2318

C10





Inside Information!

Illustrated is the "BROOMWADE" type WR120 Portable, two-stage, Rotary Air Compressor Plant and a cross-section of the Compressor unit.

The design of the compressor ensures that there is no violent change in the direction of air flow. The rotors are set in parallel and the air flows smoothly from the L.P. to the H.P. stage in an "S" curve pattern as indicated in the cross-section.

Setting the rotors in parallel the two stages can be operated at different speeds, permitting each rotor to attain its most efficient peripheral speed in relation to diameter. The sliding vanes in the rotors are thus subjected to the required centrifugal force, ensuring a perfect seal and maximum compression—volumetric efficiency is over 90%.

Flexibility of speed between stages and drive from the engine to the L.P. rotor allows a running speed well within the engine's recommended speed range. The result is a well matched engine/compressor plant having a large horsepower reserve, ensuring long engine life.

"BROOMWADE" Rotary Plants are:

SMALLER in size. **LIGHTER** in weight. **CHEAPER** and **EASIER** to maintain.

Plants available from 120–630 c.f.m.

For full details write for Publication No. 333 R.C.E.

"BROOMWADE"

Air Compressors & Pneumatic Tools — Your BEST Investment

BROOM & WADE LTD., P.O. BOX NO. 7, HIGH WYCOMBE, ENGLAND.

Telephone: High Wycombe 1620 (10 lines) *Telegrams: "Broom", High Wycombe. Telex: 15 - 527*

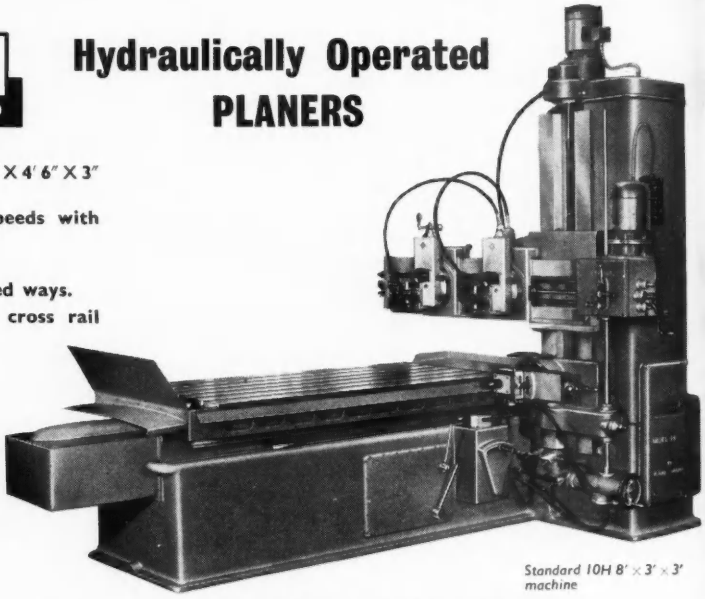
716 SAS

INVICTA
HYDETSCO

Hydraulically Operated PLANERS

- ★ 17 sizes 3′ × 3′ × 2′ 6″ up to 14′ × 4′ 6″ × 3″ capacity.
- ★ Infinitely variable table speeds with quick return.
- ★ Hydraulic tool lift.
- ★ Automatic lubrication of bed ways.
- ★ Rapid vertical traverse of cross rail standard.
- ★ Centralised controls.

Additional tool head on cross rail. Milling heads. Grinding heads. Rapid cross traverse of heads. Outer support for cross rail. Concertina guards for all ways are available to order. Double column machines available on request.



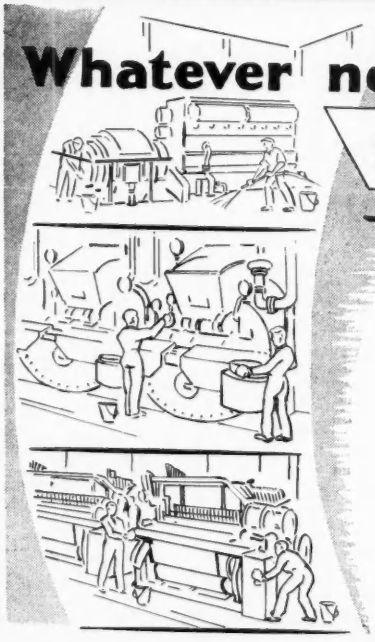
Standard 10H 8′ × 3′ × 3′ machine

B. ELLIOTT (MACHINERY) LTD.
(MEMBER OF THE B. ELLIOTT GROUP)
VICTORIA WORKS, WILLESDEN, LONDON, N.W.10
Telephone: ELGar 4050 (10 lines) Telegrams: Elliottona, Harles, London
Overseas Subsidiaries: CANADA, U.S.A., AUSTRALIA, S. AFRICA

ELLIOTT OF LONDON GROUP

NRP 251

Whatever needs cleaning — grease is no problem —thanks to GUNK!

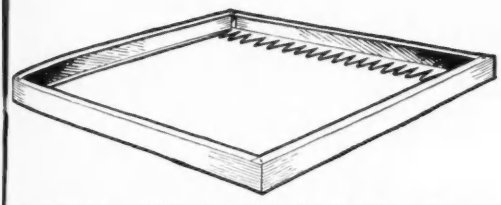


When machinery is idle it is costing you money—therefore it is essential that the important job of cleaning and maintenance should take the least possible time. That's where GUNK comes to your assistance, for it provides the complete answer to the problem of oil and grease. All you do is brush it on and then rinse it off with cold water, and all traces of oil and grease have instantly disappeared. It is clean to use and requires no preparation. And you can use it anywhere—all types of machinery, floors, walls, etc.

Supplied in 5, 10 and 40/45 gallon drums. **Send for free sample and prove for yourself how effective Gunk is!**

Gunk

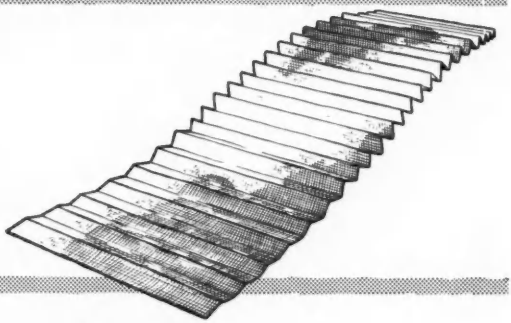
Manufactured by
BENNETT (HYDE) LTD., BOSTON MILLS, HYDE, CHES. Tel. HYDE 1377/8/9

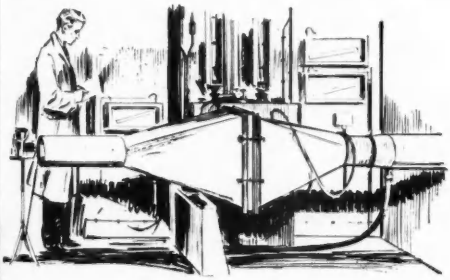


A low-cost expendable frame

fitted with a large area of unique filtering medium,

The synthetic fibrous medium is impregnated with a newly developed adhesive which adds to its efficiency and effective life. Unaffected by moisture, non-cracking, and free from fibre migration, the medium is supplied in flame-resistant form. It is pleated to present the greatest possible filter surface in the most compact space.





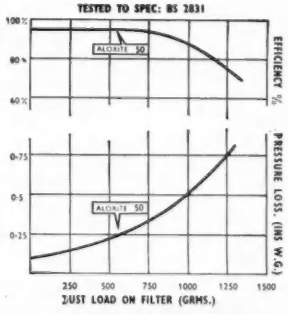
backed by all the resources of Vokes laboratories,

Vokes is an entirely British company and therefore tests its filters to British standards. All Vokes air filters are tested to BSS 2831 in their well-equipped laboratories, where research into new filter materials is continuously carried on.

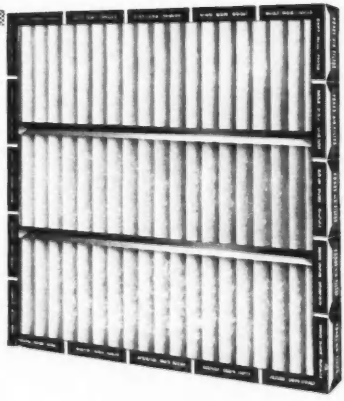
make up Vokes new *Super-Vee** Air Filter

Vokes Super-Vee Air Filter with its sustained efficiency under severe industrial pollution and smog conditions is the best low-cost, long life expendable air filter for paint finishing plant, chemical laboratories, textile plant, distilleries, nuclear power plant and most heating and ventilating applications. IT IS FULLY INTERCHANGEABLE WITH OTHER SIMILAR PANELS. Comprehensive testing to BSS 2831 showed that the dust-holding capacity for a given rise in pressure loss, with no drop in efficiency, exceeds that of any other filter panel of this class.

* *Registered Trade Name*
WORLD WIDE PATENTS PENDING



TESTED TO BSS 2831



Size for size with similar filters the Super-Vee offers up to 25% greater capacity thereby considerably reducing the number of panels needed for any particular application, allowing a more compact installation *and* lower maintenance costs.

VOKES

VOKES LIMITED • HENLEY PARK • GUILDFORD • SURREY

Telephones: Guildford 62861 (6 lines)
Telegrams: Vokesacess, Guildford, Telex.

Telex 13-535 Vokesacess, Gfd.
Represented throughout the world.
V503

SULPHITE LIQUOR

Dilute Sulphuric Acid

Water and Sludge

DETERGENT SOLUTIONS

HOT WATER

COLD WATER

Dilute Alkalis

D'you call these lubricants? . . .

—You do, if you're using 'ORKOT' bushes. Made in resin-bonded fabric they function equally well with conventional and unconventional lubricants.

Greases, oils, soluble oils, water, acids and many loathsome chemical process liquors—even sludges—they are all lubricants to 'ORKOT'.

If you have a lubrication problem, you should know more about 'ORKOT.'

and don't forget when you use 'ORKOT' you also get:-
Lower coefficient of friction
Reduced wear on bearing and shaft
Lower Power Loss and Freedom from Corrosion

. . they're all lubricants to . . .

* **Orkot** BUSHES

Enquiries to:—
UNITED COKE AND CHEMICALS COMPANY LIMITED
(SALES DEPARTMENT 485) P.O. Box 136, Handsworth, Sheffield
Telephone: Woodhouse (Sheffield) 3211. *Telegrams: 'Unichem' Sheffield*

Solve your power transmission problem

IT

REDUCES
The peak amperage during starting

ELIMINATES
Starting shock and snatch

PREVENTS
Overloading electric motors and burning them out
Breakage of fragile materials due to sudden starting shock.
Damage due to overload.

INCREASES
The life of belt and gearing

PERMITS
Inching and rapid reversal.

SAVES
The cost of high starting torque motors.

RELIEVES
The motor of load.

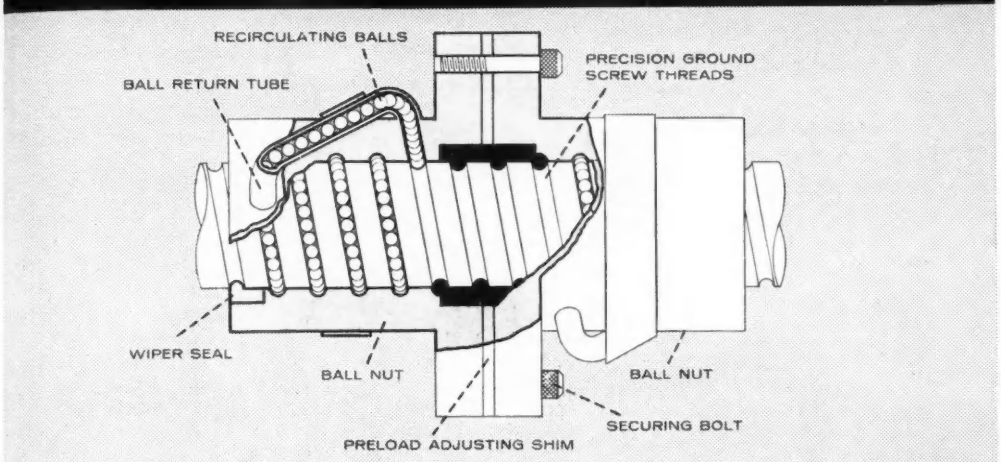
with the amazing

DRY FLUID CENTRIFUGAL COUPLING

For technical information and assistance write to . . .

POWDER COUPLINGS LTD.,
A Member of the Specialloid Group of Companies
20 BLACK BULL STREET, LEEDS, 10
Telephone: LEEDS 20936 & 31471/7

Beaver pre-loaded ball screws, up to 95% efficient, operate at -52°C to over 400°C with no backlash...



...ANOTHER ENGINEERING ADVANCE FROM BRISTOL SIDDELEY

Bristol Siddeley Engines Limited produce Beaver* pre-loaded ball screws. These ball screws achieve a minimum efficiency of 90% and they can operate within a temperature range of –52° C to 400° C without lubrication, and up to 170° C when lubricated.

Machined and ground to the highest standards of precision engineering Beaver pre-loaded ball screws greatly increase transmission efficiency. They reduce the power required for actuation by as much as 80%, when converting rotary drive into linear output or force input into torque output. By eliminating backlash, with pre-loading, they give precise control over very small increements of motion and a high response frequency. And when compared to conventional screw mechanisms, they provide a predictable operating life which is much longer, require much less maintenance and give more trouble-free operation.

Basic design application analysis

Bristol Siddeley engineers make an exhaustive analysis of each specification. And each unit is specially designed for its particular application. Beaver ball screws are made automatically reversible or with controlled "no-back," with multiple or single circuits. Beaver pre-loaded ball screws have been proved as the most efficient method of converting rotary into linear thrust in over 2,700 engineering applications in many branches of industry. They have been designed already with rated operating load capacities of 370,000 lb (825,000 lb maximum static load) but the maximum potential operating load is, in most cases, limited only by the requirement.

Bristol Siddeley Beaver ball splines have been developed to eliminate the disadvantages of conventional splines. The designs are very effective in minimising friction, particularly when high torsional and bending loads are imposed during linear movement.

**Complete technical and manufacturing co-operation with Beaver Precision Products Inc, Detroit.*

For further information please write to:
J. B. STARKY, SALES MANAGER (BEAVER PRODUCTS DIVISION), BRISTOL SIDDELEY ENGINES LIMITED
PO BOX 17, COVENTRY, ENGLAND

BRISTOL SIDDELEY ENGINES LIMITED

Controlled Atmosphere Furnaces for special heat treatment requirements

For over 30 years Royce have specialised in controlled atmosphere furnaces—continuous or batch type—using hydrogen, cracked ammonia, nitrogen, argon, endothermic or exothermic gas. Royce service includes advice on, and the supply of atmosphere generating plant.

An example of Royce designs are the hump-back conveyor furnaces above. Perfect gas balance under continuous operation is obtained with atmosphere consumption reduced to a third of a straight conveyor furnace. No burning off at doors is required.

ROYCE ELECTRIC FURNACES LTD

Designers and manufacturers of furnaces, ovens and kilns for all industries

SIR RICHARD'S BRIDGE · WALTON-ON-THAMES · SURREY

ROYCE

NRP/RF 322

ENGINEERING ACHIEVEMENT ON MERSEYSIDE

The Birkenhead entrance to the famous Mersey Tunnel is only a few yards from AABACAS . . . makers of world renowned All-British Cranes and Hoists

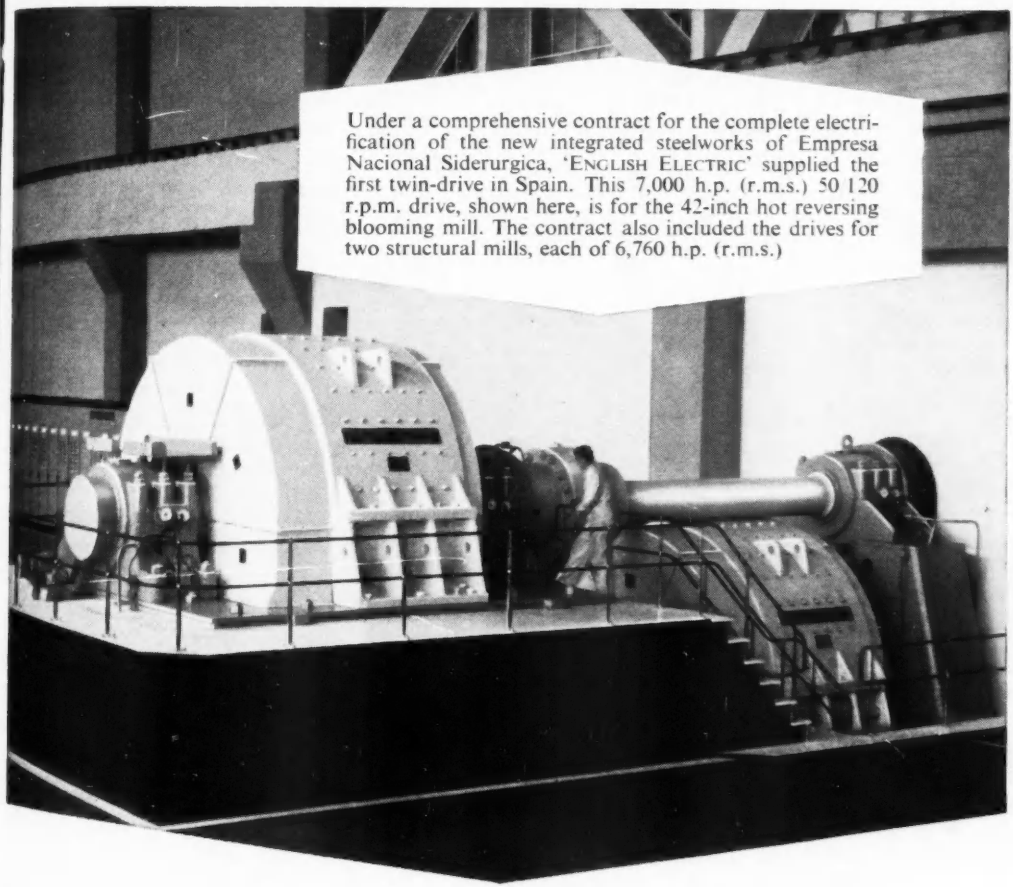
Send now for new Aabacas Catalogue to:
TECHNICAL MANAGER

AABACAS

ENGINEERING CO., LTD.

Head Office: BIRKENHEAD
Telephone: BIRKENHEAD 4747/8/9
London Office: St. Martin's House, 29 Ludgate Hill, E.C.4
Tel. City 7831/2

Technical Representatives throughout Great Britain



Under a comprehensive contract for the complete electrification of the new integrated steelworks of Empresa Nacional Siderurgica, 'ENGLISH ELECTRIC' supplied the first twin-drive in Spain. This 7,000 h.p. (r.m.s.) 50 120 r.p.m. drive, shown here, is for the 42-inch hot reversing blooming mill. The contract also included the drives for two structural mills, each of 6,760 h.p. (r.m.s.)

'ENGLISH ELECTRIC'

Power generation · Power transmission · Power control · Power distribution

Power transformation · Power conversion · Power utilisation · Power measurement

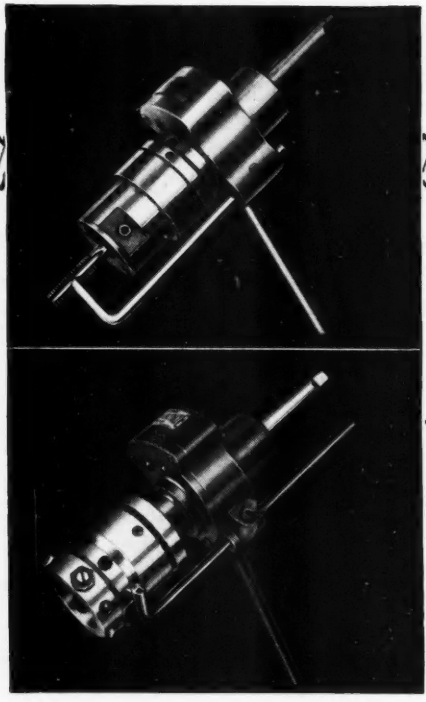
Power is our business

THE ENGLISH ELECTRIC COMPANY LIMITED, MARCONI HOUSE, STRAND, LONDON, W.C.2

Partners in Progress with NAPIER, MARCONI'S, VULCAN FOUNDRY and ROBERT STEPHENSON & HAWTHORNS in The ENGLISH ELECTRIC Group

P.81

the last word . . . .



for efficiency in tapping

The new Ackworthie range of Friction Tappers, improved and perfected after many years of research can be used on any Drilling Machine—available on trial—Write for fully descriptive folder. Ackworthie Tapping attachments will tap and screw from 12 B.A. to 1½ in. dia. at a fraction of the cost of a new machine.

PRECISION MADE SCREWING AND TAPPING ATTACHMENTS.

for efficiency in screwing

ACKWORTHIE

JOHN ACKWORTHIE LTD.,

Dalehouse Lane, Kenilworth, Warwickshire.

Telephone: Kenilworth 1530 (P.B.X.)

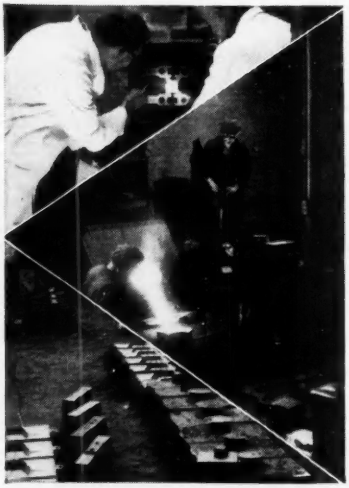
STAINLESS STEEL
HEAT RESISTING

ABRASIVE RESISTING
HEAT & ABRASIVE RESISTING

CYANIDING POTS
CASE HARDENING BOXES
CAST IRON, BRASS, GUN METAL
PHOSPHOR BRONZE, ALUMINIUM etc.

JOFO
CHROMIUM STEELS
MAGNET STEELS

HIGH SPEED TOOL, DIE & SPECIAL ALLOY STEELS
also STAINLESS STEEL ROAD LINES, STUDS & SIGNS . . .



HIGHLY ALLOYED STEEL

CASTINGS

'JOFO' castings are available in a wide range of qualities

From a few ozs up to 10 cwts each

M.O.S. approved inspection facilities installed
Routine X-ray control

H. Johnson Foster Ltd

Regd. Office and Works:
BROADFIELD RD., SHEFFIELD 8.
Telephones: 52431/4

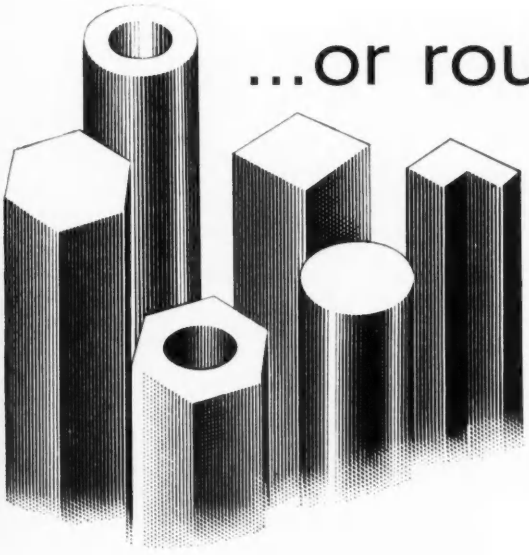
Office and Works Entrance:
AIZLEWOOD RD., SHEFFIELD 8.

Foundry : Aizlewood Road, Sheffield
Machine Shops : Broadfield Road, Sheffield
London Office : Central House, Upper Woburn Place, W.C.1. (EUSton 4086)
Glasgow Office : 93 Hope Street, C.2. (Central 8342/5)

H. JOHNSON FOSTER LTD. STEELMAKERS & FOUNDERS

Clever stuff?

...or routine job?



BOTH at Vickers.
All types of extrusions
in brass. Fine limits,
good quality, quick delivery.

Write or phone
for information to:

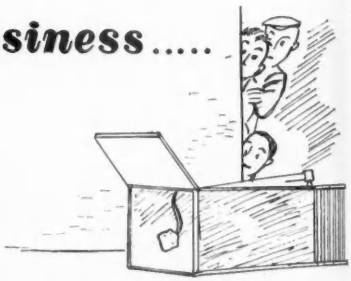
Non-Ferrous Metals Department
(Division 1),
Vickers-Armstrongs (Engineers)
Limited,
Elswick Works,
Newcastle upon Tyne.
Telephone: 33101

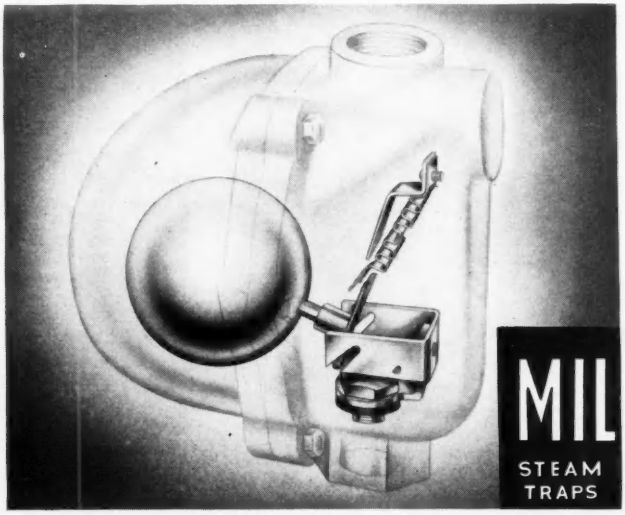
Brass extrusions by VICKERS

Vickers-Armstrongs (Engineers) Limited

TGA EN36A 1

steam trapping is our business.....





The MIL FLOAT TRAP is a worthy companion to the MIL range of Thermostatic Steam Traps. It has been designed especially for use on those applications where a rapid heat transfer rate is essential. Compact and robust in design, having generous discharge capacities it incorporates an indestructible bimetallic element ensuring that the valve is held in the fully open position when cold to vent air readily.

For draining compressed air lines a specially adapted version of the MIL Float Trap is available.

MIDLAND INDUSTRIES LTD.
HEATH TOWN WORKS, WOLVERHAMPTON

Telephone: 23901
London Office: 28 Victoria Street, S.W.1
Glasgow Office: 69 St. Vincent Street, C.2

Have you a heat treatment problem?

Made in a wide range of standard sizes or built to customers specifications, AEW Electric Ovens and Furnaces embody the most advanced features for all Industrial Heat treatment processes.

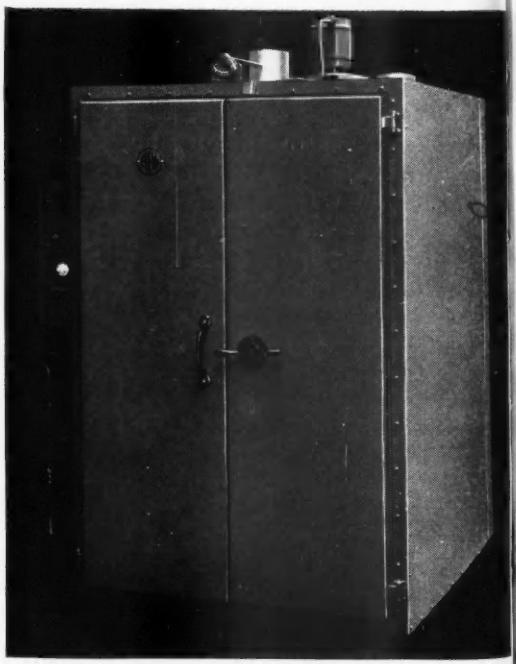
Standard ovens built for temperature up to 400°C.

High temperature ovens suitable for temperatures up to 750°C.

Our Technical Advisory Service is freely available for solving your heating problems.

Please write for fully informative brochure.

A. E. W. Ltd.
Imperial Works, Edgware, Middx.
Telephone: Edgware 5278



Type 1077 Standard Industrial Oven.

A high degree of machining finish is required for this operation. The very fine grain size associated with Automat Regd. cast iron makes it eminently suitable for thread-cutting operations. Remember, too, there is a marked increase in tool life. Specify Automat Regd. for your castings.

Automat (Regd.) Pig Iron for the production of Automat (Regd.) Iron Castings. Full details available on application.

REFINED IRON CO. (DARWEN) LIMITED

SPRING VALE WORKS, GRIMSHAW STREET, DARWEN, LANCASHIRE

Telephone: Darwen 1745/6/7. Telegrams: "Rolingot Darwen".

* *Also producers of Darwen Brand Refined Cylinder and Malleable Pig Iron.*

* *Special Alloy Pig Iron and Hi-Carb Iron.*

CHATWIN

THREE operations in ONE!

polygon tool box

turns hexagons, octagons, squares or other shapes in ONE operation, saving time and money and speeding up production.

With the Polygon Tool Box in your machine shop, you can do three times more work than normal.

Write today for a copy of the booklet on the Chatwin Polygon Tool Box.

THOMAS CHATWIN & CO.

Gt. Tindal St. Birmingham 16. *Tel: Edgbaston 3521.*
London: 25 Hanover Square, W.1. *Tel: Mayfair 8783.*

Area Sales Offices in Newcastle-upon-Tyne, Bristol & Manchester.

multi-spindle drilling attachments

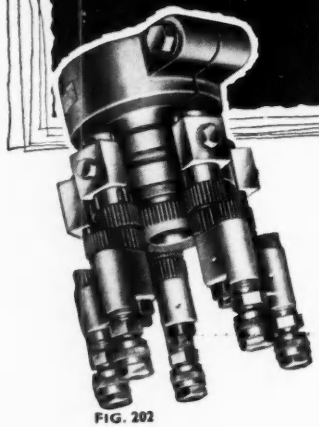


FIG. 202

multi-spindle tapping attachments

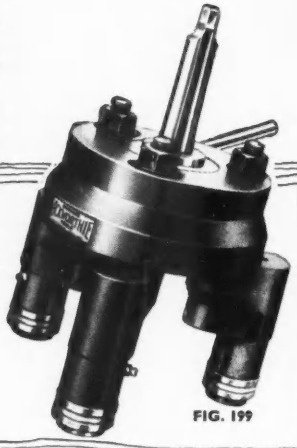


FIG. 199

Multi Spindle Drilling—Multi Spindle Tapping, 2 Spindles to 20—fully adjustable or fixed. Send today for your copy of "Automation by Ackworthie/C"

Illustrated Ackworthie Multi Spindle Drilling attachments Fig. 202 and Fig. 199 designed to give a wide range of Spindle adjustment. Special Machines built to customers' requirements.

ACKWORTHIE

JOHN ACKWORTHIE LTD
Dalehouse Lane, Kenilworth, Warwickshire
Telephone: Kenilworth 1530 (P.B.X.)

FOUR helpful publications

Constant research has ensured that Walpamur Industrial Finishes meet every requirement of modern industry, and these four free publications will help you to make the best possible use of this extensive range.

CATALOGUE OF INDUSTRIAL FINISHES describes the pre-treatment of metal surfaces before painting and gives details of primers, fillers and stoppers, stoving finishes,enamels, nitro cellulose finishes etc.

EPOXY RESIN PAINTS booklet details the complete range of FEROX epoxide resin based paints, including stoving, air drying, and cold cure finishes for many industrial requirements.

SILICONE LEAFLET gives information about the use of silicone in heat resisting and water repellant paints, bonding varnishes, etc.

INDUSTRIAL SHADE CARD shows the complete range of colours available for all types of finishes.

All are obtainable free on request to:

THE WALPAMUR COMPANY LIMITED
DARWEN AND LONDON

Paints, Enamels, Varnishes and Finishes for every industrial need

BY APPOINTMENT
TO HER MAJESTY THE QUEEN
MANUFACTURERS OF PAINT

W849

Light * strong * corrosion-resistant

TITANIUM

Most people concerned with metals know what it is
but not everyone is aware of what it can do.
If you feel that you should know more about this
light, strong and corrosion-resistant metal,
then write for brochure on properties and forms to:

TITANIUM METAL & ALLOYS LTD
2 METAL EXCHANGE BUILDINGS, LONDON, E.C.3. Tel. Mansion House 4521
WORKS: SHEFFIELD
"ROLLERS OF MODERN METALS"

CAPSTAN AND AUTOMATIC PRODUCTIONS

SPECIALIST MACHINING AND GRINDING

CENTRELESS GRINDING

DEEP DRAWN DRAWING

G·G·L

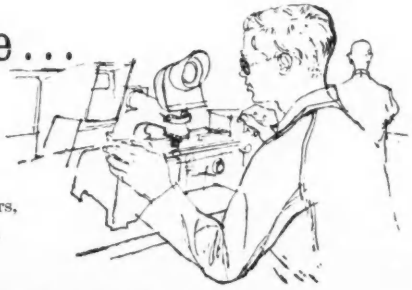
LARGE AND SMALL PRESSING

You can count on
GRIFFITHS, GILBART, LLOYD. & CO. LTD.
EMPIRE WORKS, PARK ROAD, BIRMINGHAM 18
Telephone: Northern 6221

ANY METAL ANY QUANTITY

Makers of scientific instruments since 1856

Make an instrumental note . . .



that if you have anything to analyse, to measure, inspect, or survey, the people to help you are Hilger & Watts.

Autocollimators, Block Levels and Clinometers, Circular Division and Angle Measuring Instruments, Dividing Engines, Linear Measuring Machines, Microscopes, Gauge Interferometers, Optical Flats, Angle Gauges, Polygons, Etc., Scales and Circles, Projectors, Analytical Instruments, Surveying Instruments.

HILGER AND WATTS LTD · 98 ST PANCRAS WAY · LONDON · NW1

HILGER & WATTS LTD., WITTEN-ANNEN, GERMANY

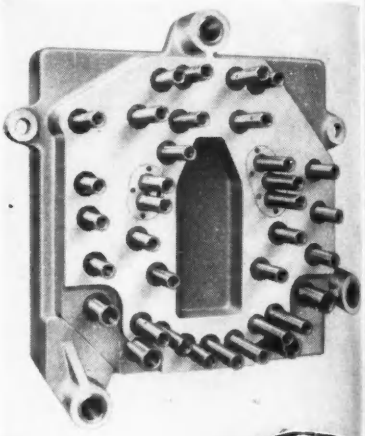
HILGER & WATTS INC., CHICAGO 5, U.S.A

CONSULT **SPK**

the experienced multi-drilling specialists

We manufacture all types of multi-drilling equipment from a simple two-spindle adjustable model to a multi-head that will drill a large cylinder block in one operation. SPK multi-heads are built up from a range of standardized interchangeable spindle assemblies and housings, which have been developed as a result of many years' practical experience, resulting in the minimum cost and a proved performance.

Could our equipment and experience assist your product?



SLACK & PARR LIMITED
KEGWORTH . Nr. DERBY
Telephone: Kegworth 306

THORP EQUIPMENT FOR THE GAS INDUS

GAS FLOW INDICATORS

Direct Reading, variable aperture type, from 0 to 150 lb./sq. inch.

For all types of gases; can be calibrated to customers' requirements. Brass body, stoved black crinkle finish.

Cast Iron Body for Corrosive Gases.

Scale Plate in black crinkle, chrome or polished brass.

All Unions, etc., chrome plated.

Stainless Steel Float, in clear glass tube.

Customers when ordering should state—
(*a*) Specific Gravity and Working Pressure.
(*b*) Maximum and Minimum Rates of Flow.

Size B.S.P. ins.	Max. Cu. ft. Coal Gas 5/10"
¼	
⅜	
½	
¾	
1	
1¼	
1½	
2	
2½	

THOMAS THORP & CO LTD
WHITEFIELD Manchester

NEWTON CHAMBERS

now cast in MEEHANITE

Our large modern foundries at Thorncliffe can now produce all classes and sizes of castings in the various types of Meehanite metal. This important addition to our already very extensive foundry facilities enables us to offer an exceptionally skilled and comprehensive casting service. Our long experience of serving almost every major industry gives us a unique understanding of special needs and problems.

Whether you require one casting or thousands, we can meet your needs promptly, in sizes from a few pounds up to 20 tons in weight. Production methods include light, medium and heavy machine moulding, as well as floor, loam and shell moulding. A skilled patternmaking service is at your disposal. Your machining and fitting requirements can be undertaken by our fully modernised machine shops.

All enquiries will receive immediate attention.

Newton Chambers ENGINEERING DIVISION · THORNCLIFFE · SHEFFIELD

ENGINEERS OF PROGRESS

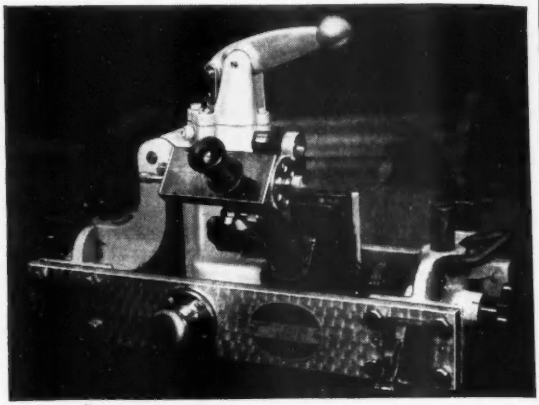
Taking the measure of **HARDNESS**

The Vickers Portable Hardness Tester

The Vickers Portable Hardness Tester incorporates all the well-known features of the Vickers Pyramid Hardness Testing machine. The standard Vickers Pyramid Diamond Indenter is used in conjunction with the Micrometer Ocular, so that all readings obtained are the internationally recognised VPN. Combined with this accuracy is a portability which enables it to be used over an exceptionally wide range of applications, and it is particularly useful for large and heavy components which cannot be tested by the standard Hardness Tester.

The Vickers Pyramid Hardness Testing Machine—compact in size and comprehensive in service, it enables immediate and precise testing to be carried out at the place of production.

The Vickers Portable Gear Hardness Tester—similar in principle to the general purpose Portable tester, but specially developed to measure the hardness on the pitch line of gears.



Taking the hardness of a large-diameter shaft

Please send for a catalogue giving full details.

VICKERS

VICKERS-ARMSTRONGS (ENGINEERS) LIMITED

13 City Road . London E.C.1.

Tel: METropolitan 8877. 'Grams: Vicksbox, Ave., London

TGA. CH61

View with cover removed.

MEDDINGS

Pacera

AIR HYDRAULIC UNIT DRILL HEAD SERIES

OVERALL WIDTH (with cover) ONLY 4 3/16"

Specially designed for light, high-precision work. Specification includes the following features . . .

★ 4 SPINDLE SPEEDS—MAXIMUM 10,000 R.P.M.

★ INFINITELY VARIABLE FAST APPROACH AND FEED

★ RAPID OPERATION—FAST APPROACH AND RETURN AT RATE OF 12" PER SECOND

★ VERY LOW AIR CONSUMPTION

★ DRILLING CAPACITY— 5/32" IN ALUMINIUM, 3/32" IN STEEL

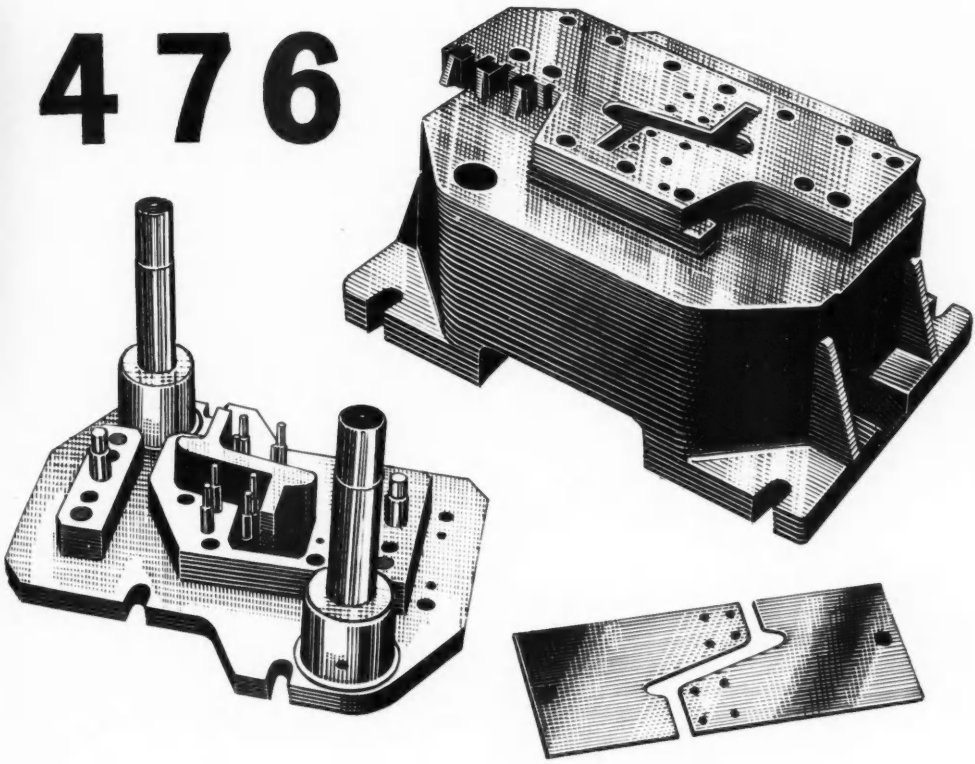
Write for full particulars to the Manufacturers

W. J. MEDDINGS LTD

IPSWICH ROAD, TRADING ESTATE, SLOUGH, BUCKS. **Tel: SLOUGH 2239**

SANDERSON tool steels

476



'476' Heavy Duty Die Steel of the high carbon, high chromium type, has outstanding wear-resistance yet is tough and machinable. It is particularly recommended for tools operating under conditions of severe wear and abrasion and where maximum runs are required. The above illustrations show a punch and die set produced from '476' steel by The Mining Engineering Co. Limited, Worcester.

SANDERSON'S ESTABLISHED 1776

STEEL SAWS TOOLS

Please write for further details and literature to

SANDERSON BROTHERS AND NEWBOULD LIMITED

Attercliffe Steelworks, P.O. Box 6, Newhall Road, Sheffield 9

Special Anti-Corrosion.

"EPINAMEL" LININGS

FOR STORAGE TANKS, MOBILE TANKS, CHEMICAL PLANT

A well established process resistant to abrasion and corrosion and to the action of chemicals, water and propellent fuels Possessing maximum hardness without brittleness

HOLDENS "EPINAMEL"

Full Details From
ARTHUR HOLDEN & SONS LTD., BORDESLEY GREEN RD., BIRMINGHAM, 9
Telephone: Victoria 2761 (5 lines)

PRESSINGS

If you require pressings consult Ward (Metal Details) Ltd. We are specialists in the manufacture of all types of small and medium pressings of any shape, size and thickness, in steel, tinplate, copper etc. from which complete assemblies can be fabricated by welding, soldering or brazing.
Illustrated here are some examples of our products, and similar components can be produced to your own specification and design, and supplied in painted, plated or enamelled finishes.

WARD
(METAL DETAILS) LTD.

DARLASTON · STAFFS

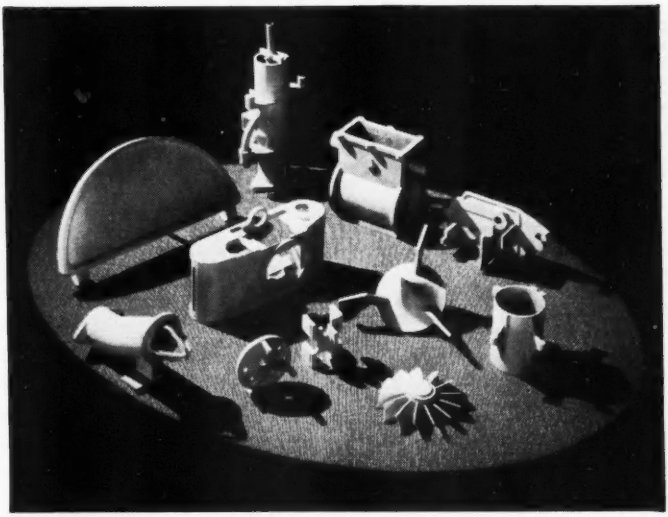
Non-ferrous investment castings

SMITHS Autop Investment Foundry is ideally equipped to produce investment castings IN NON-FERROUS METALS

A.I.D. & A.R.B. APPROVED

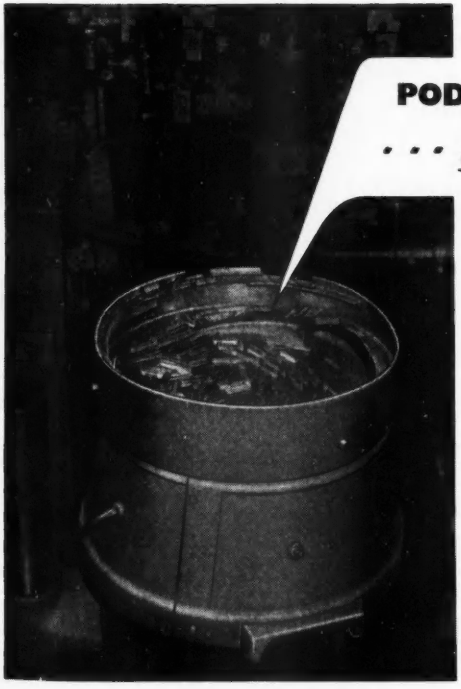
Enquiries should be directed to

AUTOP FOUNDRY



SMITHS MOTOR ACCESSORY DIVISION

OTTERSPOOL WAY, WATFORD BY-PASS, WATFORD, HERTS. TELEPHONE: WATFORD 28522



PODMORE BOWL FEEDERS

. . . *REDUCE LABOUR COSTS!*

AND INCREASE PRODUCTION

Time is money where such processes as the feeding of small components for packing, counting, inspection, sorting or further processing is concerned. It is of paramount importance in the modern works that these operations are AUTOMATIC . . . and that's where PODMORE BOWL FEEDERS come in.

Our illustration shows a 12-inch bowl feeder, feeding and orientating small pressings to a fixed position from which they are transferred to the press die by means of a "Mechanical Hand". By the use of Bowl Feeding, one operator can attend several presses. This is just one of the many special applications for which we are regularly building Bowl Feeders.

Fully descriptive literature on application.

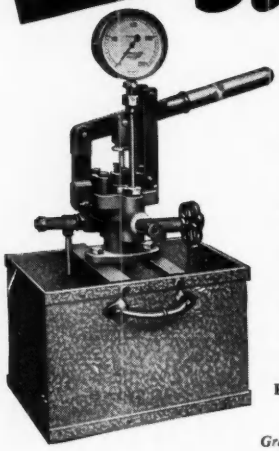
PODMORES (ENGINEERS) LTD

HANLEY · STOKE-ON-TRENT.

Tel: Stoke-on-Trent 23257-8

TEST PUMPS?

RING **Bailey's** REGD.



Immediate delivery available from a wide range of sizes and types for all industrial purposes from 300 p.s.i. to 45,000 p.s.i.

Illustrated: Hand-operated concentric ram test pump, with 2 in. ram for rapid filling of vessel to be tested and $\frac{5}{8}$ in. ram for obtaining the pressure. Suitable for pressures up to 1,500 p.s.i.

SIR W. H. BAILEY & CO. LTD
PATRICROFT · MANCHESTER

Phone: ECCLES 3487-8-9
Grams: BEACON TELEX ECCLES.

LONDON OFFICE: Selinas Lane, Dagenham, Essex. Tel. Dominion 2277

SLUICE VALVES · REDUCING VALVES · TEST PUMPS · TURNSTILES

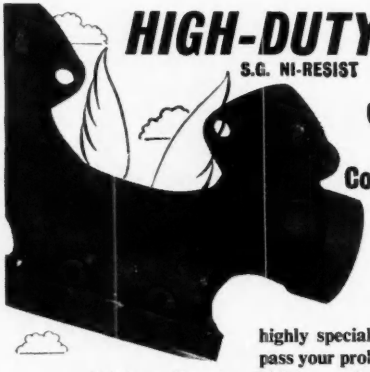
A difficult one?

Makers of Fine Quality Precision Springs & Presswork for over a Century

Consult

Unconditionally guaranteed under conditions of normal usage.

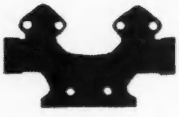
BROADBENT & CO. (ROCHDALE) LTD.
Grove Spring Works, **LINCOLN STREET,**
ROCHDALE, Lancs. *Phone: Rochdale 4628-9*



HIGH-DUTY S.G. NI-RESIST **Alloy Iron Castings and Components**

If you need a casting or component for a difficult or highly specialised application, pass your problems to the John Williams Foundry Division — they'll do the rest.

THIS turbo blown diesel engine exhaust manifold, cast in S.G. Ni-Resist alloy iron, stands up to extremely high working temperatures.



See us on Stand 84 at the first Engineering Materials & Design Exhibition and Conference at Earls Court Feb. 22-26.

A COMPLETE TECHNICAL AND FOUNDRY SERVICE

Backed by advanced research laboratory facilities. For a consultation—without charge or obligation—or a copy of our technical booklet "Sound and Solid Castings"—write to:—

JOHN WILLIAMS OF CARDIFF LTD

EAST MOORS ROAD, CARDIFF Tel: Cardiff 33622 (12 lines)
Telex 49303

Welconstruct *serves* ***INDUSTRY***

WITH
SLOTTED STEEL SHELVING
STEEL PARTITIONING
STEEL LOCKERS etc.

Send for Price List and Catalogue "G"

"642" PANS

Specially designed for small part storage, etc. 6" x 4" x 24G Steel, pressed in one piece. Liquid tight. Turned edges. Stove enamelled green. Very strong.
100 - 1/9 each. 1,000 - 1/7 each.
If unpainted, 3d. less in each case.
Carr. extra.

GALVANISED STACK TOTE PANS

Strongly made of 22G Galvanised Steel. Wired rims, drop handles. Rustproof. Prices inc. punched card holders. Min. order 25.
SPECIAL PRICES:

12"x12"x6"	18"x12"x6"	24"x12"x6"
100 6/6	7/7	8/8 each
1,000 6/-	7/-	8/- each

Carr. 5% extra.

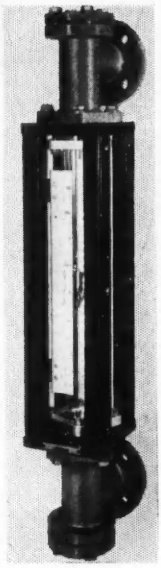
WELCONSTRUCT CO. LTD.
MARTINEAU ST., BIRMINGHAM, 2. MIDland 1691

Fluid measurement and control

Rate of Flow

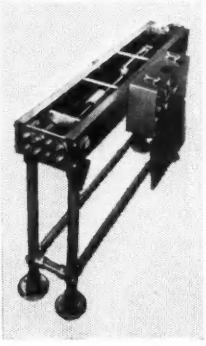
● INDICATORS ● TRANSMITTERS
● CONTROLLERS ● ALARMS

Ranging from simple glass tube Rotameters, some ex. stock, to large direct indicating and/or transmitting Rotameters for flow control systems.



Level

Ekstrom Safety Liquid Level Indicator for corrosive inflammable or toxic liquid, eliminates the hazards of gauge glass breakage and can also operate control or alarm devices.



Density

The R.M. Density Meter provides either a pneumatic or electric signal linearly related to density change. Slurries can be handled by the instrument, which detects density changes of the order of .002 gm/ml.

ROTAMETER
FLUID MEASUREMENT AND CONTROL
FLOW-DENSITY-LEVEL

G.20a

Booklet ED2125/20a, free on request, describes the Rotameter range of instruments

ROTAMETER MANUFACTURING CO. LTD.
PURLEY WAY, CROYDON, SURREY. Telephone: Croydon 3816

BRAYSHAW

RADIUS GRINDING ATTACHMENT FOR MILLING CUTTERS *(Patent applied for)*

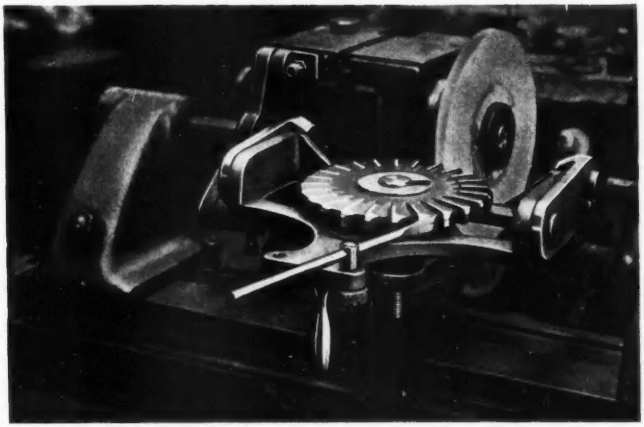
- NEW
- SIMPLE DESIGN
- EASY TO USE
- INEXPENSIVE

For accurate convex radii on :
Side and Face Cutters
Slotting Cutters
Angle Cutters

Can be used on standard types of Cutter Grinders, Cylindrical Grinders or Lathes fitted with toolpost grinding attachments.

CAPACITY : Cutters 3 in. to 8 in. diameter, 1½ in wide. Radii up to ⅝ in.

Full particulars on application.



BRAYSHAW TOOLS LIMITED
BELLE VUE WORKS, MANCHESTER 12

Telegrams : "HARDENING", Manchester. Telephone : EAST 1046.
LONDON OFFICE: 21 LIVERPOOL ST., E.C.2 Phone: AVENUE 1617-8

"As clean as a Gloucester Casting" means that Gloucester malleable iron castings are of high definition, true to pattern, cleaner and smoother because of better sand practice and better fettling. Mould and core sands and their bonding additives are under constant laboratory supervision, even the very sand grains are sized and numbered, and consistency and distribution of sand are strictly controlled by a continuous mechanical unit.
The new elevator-type electric furnace anneals in 48 hours!—instead of the usual 7 days. It also allows greater control of the component during annealing, resulting in uniformity of metal, greater strength, and resistance to impact.

...as sound as a Gloucester casting!

A typical Gloucester Malleable specification.

Gloucester Blackheart Malleable		*Gloucester Lamellar Pearlitic Malleable*	
Elongation	18%	Elongation	5%
Yield Point	12 tons	Yield Point	24 tons
Tensile Strength	25 tons psi	Tensile Strength	35 tons psi

Bearing bracket in Malleable Iron. Weight 3¼ lbs.

Brake shoe for small vehicle in Malleable Iron.

GLOUCESTER

Gloucester Foundry Ltd., Emlyn Works, Gloucester
Telephone: Gloucester 23041. Telegrams: 'Pulleys' Gloucester
(A subsidiary of the Gloucester Railway Carriage & Wagon Co. Ltd.)

Water in your air lines?
VICTOR CAN HELP!
Please write for Booklet No. C. A. 100 to
VICTOR PRODUCTS (WALLSEND) LTD.,
WALLSEND-ON-TYNE

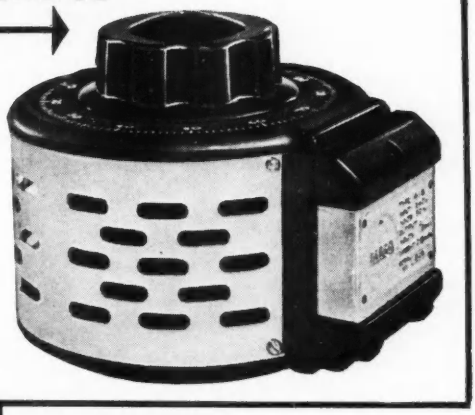
NITRIDED
Nitralloy
STEELS

The Nitriding Process for Case-hardening Special Steels by Nitrogen Offers

- **Surface hardness up to 1100 D.P.H.**
- **Retention of full hardness after heating to 500°C.**
- **Maximum resistance to frictional wear and fatigue.**
- **Improved resistance to corrosion by water and steam.**

Particulars from:–
NITRALLOY LIMITED ATLAS WORKS SHEFFIELD, 4.
Telephone: Sheffield 26646. *Telegrams: "Nitralloy, Sheffield"*

A UNIVERSAL A.C. VOLTAGE & CURRENT CONTROL
. . . with universal fixing centres



For the most up-to-date variable transformers . . . for early delivery, too, the obvious choice is the Berco Rotary Regavolt, model 42A, rated at 580 V.A. With a maximum input voltage of 250 V. it will supply a variable output from 0-270 V. Moderately priced at £7.0.9*d.* (skeleton type) and £8.5.11*d.* (protected type as illustrated) the Berco Rotary Regavolt represents the finest value today at the lowest cost.

* **CONSTRUCTION:** Toroidally wound auto-transformers, with tracks formed on one face of the windings.
* **CORE:** Wound from a continuous strip of low loss electrical steel in a similar manner to the well-known C core construction.
* **INSULATION:** Specially processed plastic mouldings ensure minimum shrinkage due to heat and continuous use, and prevent any possibility of the turns slackening.
* **WINDING:** Of high conductivity copper, insulated with a synthetic enamel of the polyvinal acetal-phenal formaldehyde resin type, giving good space factor, exceptionally high abrasion resistance and prolonged heating resistance.
* **FRAME:** Of die cast aluminium, incorporating long spindle bearings and mounting feet to ensure accuracy and rigidity of the mechanism in relation to the fixing holes.
* **BRUSHES:** The brushes are of a special carbon for its contact resistance characteristics, shaped to give minimum loss, maximum strength and longest life.

BERCO

* *Write for list 615A giving full technical details of this and other models in the Rotary Regavolt range.*

THE BRITISH ELECTRIC RESISTANCE CO. LTD.,
QUEENSWAY, MIDDLESEX
Telephone: HOWard 2411 Telegrams: Vitrohm, Enfield
Specialists in the control of current and voltage for more than 25 years

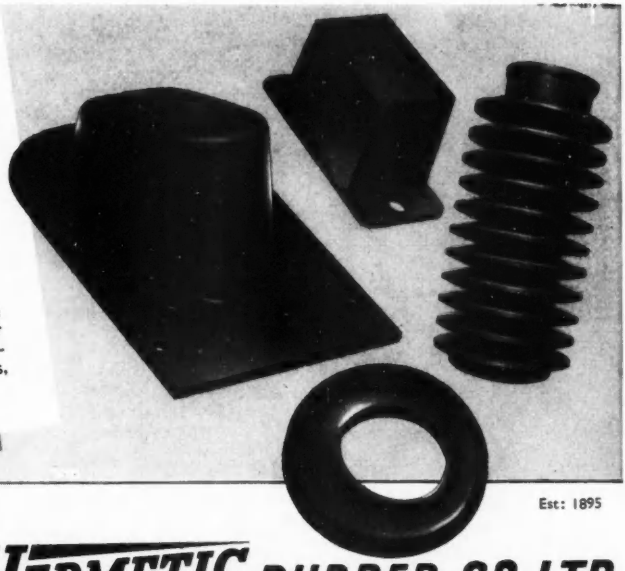
BR1341-BXH

HERMETIC RUBBER PRODUCTIONS

To meet every need of Modern Industry in current production or future development.

Our many years of experience as manufacturers in Natural or Synthetic Rubber are at your disposal.

Moulded Products of all kinds, Flexible Fabric Coupling Discs, Extruded Rubber Sections, Radiator Hose (Canvas Inserted), Mud and Stone Deflectors, Mats and Matting.



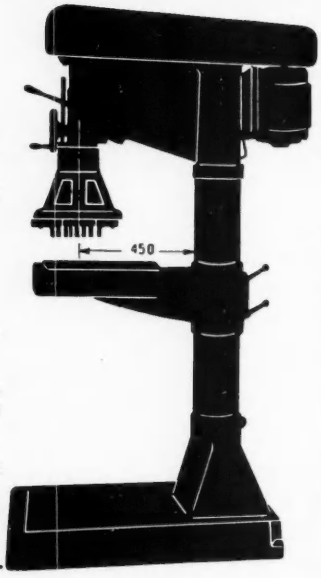
Est: 1895

HERMETIC RUBBER CO. LTD.

RYLAND STREET. BIRMINGHAM, 16

Telephone: Edgbaston 0983/4
Grams: Hermetic Birmingham

COMPLETE RANGE OF BENCH, PILLAR, AND AUTOMATIC DRILLING MACHINES



From 6 to 50 mm capacity.

Multiple drilling heads with fixed, variable and in-line arrangement.

SPECIAL MULTIPLE DRILLING HEADS TO CUSTOMERS' DESIGNS.

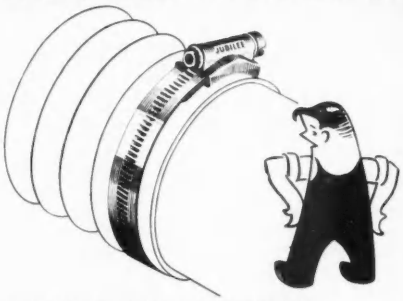
Agents wanted for unrepresented countries.

Fabbrica Italiana Trapani

IDEAL MILANO-Italy

Piazzale PASOLINI, n.2 - Telef. 694.273

THEY CAN'T FOOL ME!



I LOOK FOR THE NAME TO MAKE *SURE* THEY'RE

GENUINE Jubilee REGD. TRADE MARK

WORM DRIVE HOSE CLIPS

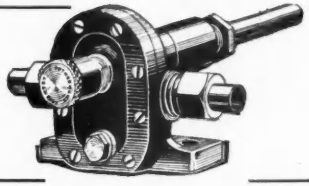
L. ROBINSON & CO., (Gillingham) LTD.,
LONDON CHAMBERS, GILLINGHAM, KENT. TEL. 51182

CAPSTAN AUTOMATIC AND SPECIAL TURNED WORK

ALSO FORGINGS AND PRESSINGS

ARMSTRONG STEVENS & SON LTD
WHITTALL STREET
BIRMINGHAM 4

GEAR PUMPS



You make the wisest choice when you decide on a GEAR PUMP by Rotherhams — the name is your guarantee of the built-in qualities you must have for the efficient year-in, year-out dependability that spells trouble-free performance.

Full information on Rotherham products, including the following, are yours for the asking.
Time Lags, Instruments, Recording Clocks, Process Timers, Pressure Gauge Movements, Small parts for Engineering, such as Taps, Oil and Grease Cups, Oil Indicators, Unions, Nipples and Olives.

Rotherhams OF COVENTRY

Rotherham & Sons Ltd., Coventry

Telephone: 64154

PRECISION MANUFACTURERS SINCE 1750

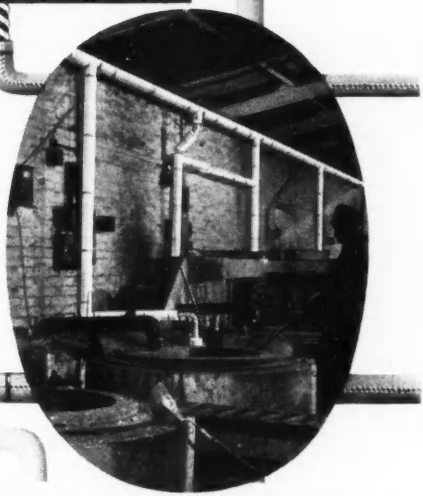
ISOTAPES *for Pipe Tracing...*

Straight Traced

Spiralled

Flexible Electric Heating Tapes
Isotapes have been specially designed to maintain at elevated temperatures, pipes carrying fuel oil, bitumen, chemicals and food products. Available in lengths ranging from 1ft. 6ins. to 290ft., Isotapes provide a choice of loadings from 5 to 40 watt. per foot— or any heating or compensating duty. They are easily and quickly applied with terminations at one end.

Latest catalogue fully documenting all surface heating units is yours on request

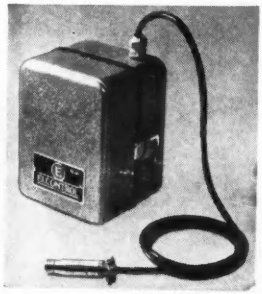


ISOPAD ELECTRIC SURFACE HEATERS

ISOPAD LIMITED, Barnet By-Pass, Boreham Wood, Herts.
Phone: ELStree 2817/8/9

photoelectric controls

small—and very accurate



a compact unit in a variety of types

THE new Elcontrol photo-relays, viewing heads and scanners have been made small so that they can be used freely on modern precision machines.
They operate with a very narrow light beam, and are very sensitive. They open up a new conception of high speed close tolerance automatic control throughout the manufacturing and handling industries.
Elcontrol photoelectrics are ideal for control jobs where movement has to be detected—tell us what you want to do and we will gladly help you.

Appointed Agents	*Telephone*
MIDLANDS: A. M. Lock & Co. Ltd., Newborough Rd., Solihull.	*Shirley 5703*
N. WEST: A. M. Lock & Co. Ltd., Union St., Oldham.	*Main 6744*
SCOTLAND: A. R. Bolton & Co., 3a St. Vincent St., Edinburgh 3.	*32035*

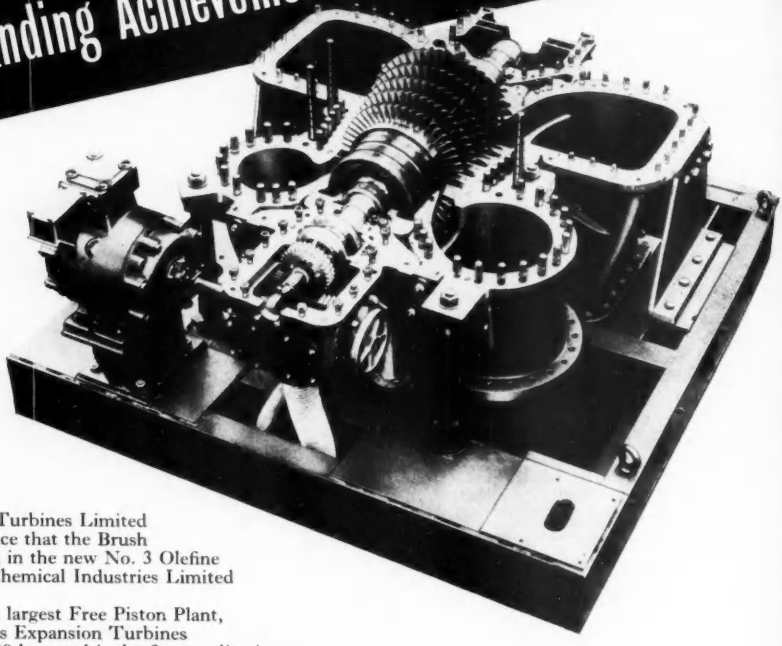
Regd. Trade Mark

ELCONTROL

write to **ELCONTROL LTD., HITCHIN, HERTS.** *Hitchin 2411*

Photograph by kind permission of I.C.I. Ltd.

An Outstanding Achievement in Free Piston Power



Hawker Siddeley Brush Turbines Limited are pleased to announce that the Brush Gas Expansion Turbines in the new No. 3 Olefine Plant of Imperial Chemical Industries Limited are now in operation.

This, the world's largest Free Piston Plant, incorporates six Gas Expansion Turbines totalling 16,000 h.p. and is the first application of Free Piston power to a Chemical Plant.

HAWKER SIDDELEY HSBT **BRUSH TURBINES LTD.**

HUCCLECOTE, GLOUCESTER TELEPHONE: GLOUCESTER 67031

TELEGRAMS: TURBINES, GLOUCESTER. TELEX

A Member of the Hawker Siddeley Group

Index of Current Advertisers and their Advertising Agents

Abacas Engineering Co. Ltd. 134
Agency—McConnell & Co. (Adv.) Ltd.
Abbey Panel and Sheet Metal Co. Ltd., The —
Agency—Willington Advertising Ltd.
Ackworthie, John, Ltd. 136 & 140
Agency—Biddle Bros. Ltd.
Acru Electric Tool Mfg. Co. Ltd. —
A.E.C. Ltd. 29
Agency—Crane Publicity Ltd.
A.E.W. Ltd. 136
Agency—G. Street & Co. Ltd.
Allen, W. H. Sons & Co. Ltd. 34
Allspeeds Ltd. —
Agency—Hyde & Partners Ltd.
Alumilite & Alzak Ltd. 10
Agency—Beresford Bourke Ltd.
Angus, George, & Co. Ltd. —
Agency—Redheads Adv. Ltd.
Archdale, James, & Co. Ltd. Cover 1
Armstrong Patents Co. Ltd. 24
Agency—Pickersgill Publicity Service Ltd.
Armstrong Siddeley (Brockworth) Ltd. —
Agency—Young & Rubicam Ltd.
Armstrong, Stevens & Sons Ltd. 154
Agency—Boswell, Barratt & Phillips Ltd.
Ashmore, Benson, Pease & Co. 1
Associated Electrical Industries Ltd. 27 & 39
Agency—T.G.A. Ltd.
Automotive Engineering Ltd. —
Agency—W. S. Crawford Ltd.
Avo Ltd. 76
Agency—National Publicity Co. Ltd.

B.I.P. Chemicals Ltd. —
Agency—Central News Ltd.
B.R.C. Engineering Co. Ltd. 13
Agency—Murray Watson Ltd.
B.S.A. Tools Ltd. Cover 4
Bailey, Sir W. H. & Co. Ltd. 150
Agency—T.G.A. Ltd.
Balfour, Arthur, & Co. Ltd. 8 & 9
Agency—Charles Stanley & Partners Ltd.
Barwell, James, Ltd. —
Agency—Beardmore Adv. Ltd.
Beakbane, Henry (Fortox) Ltd. Cover 3
Bennett (Hyde) Ltd. 130
Agency—John Willis Adv. Ltd.
Birfield Group 33, 48, & 51
Agency—Central News Ltd.
Birwelco Ltd. —
Agency—Grosvenor Advertising Ltd.
Bound Brook Bearings Ltd. 51
Agency—Central News Ltd.
Brayshaw Tools Ltd. 151
Agency—Ingham Butterworth Ltd.
Bristol Siddeley Engines Ltd. 133
Agency—Young & Rubicam Ltd.
British Bellows —
Agency—Elliott Advertising Ltd.
British Electric Resistance Co. Ltd. 153
Agency—John Mitchell & Partners Ltd.
British Geon Limited —
Agency—T. G. Scott & Son Ltd.
British Manzel Oil Pump Co. —
British Paints Ltd. 71
Agency—Redheads Adv. Ltd.
British Power Transformer Co. Ltd. —
Agency—John Mitchell & Partners Ltd.
British Rolling Mills Ltd. —
Agency—Maurice G. Parker Ltd.
British Rototherm Co. Ltd., The 28
Agency—Pitchford's Advertising Ltd.
British Timken: Division of The Timken Roller Bearing Co. 102
Agency—H. Raymond Morgan
Broadbent & Co. (Rochdale) Ltd. 150
Agency—Arthur Burns Publicity
Broady, William, & Son Ltd. 126
Agency—Harrisons Adv. Ltd.
Brockhouse, J., & Co. Ltd. —
Agency—A. N. Holden & Co. Ltd.
Bronx Engineering Co. Ltd. —
Agency—A. N. Holden & Co. Ltd.
Broom & Wade Ltd. 129
Agency—Stephens Adv. Service Ltd.
Brown, Boveri, & Co. Ltd. —
Brown, David, Corporation (Sales) Ltd. 72
Agency—Oelrichs Advertising Ltd.
Brown Fintube (Great Britain) Ltd. —
Agency—Grosvenor Advertising Ltd.
Brown, N. C. Ltd. —
Agency—Farmer Advertising Ltd.

Castings Ltd. 128
Agency—Rowlinson Broughton Ltd.
Centec Machine Tools Ltd. —
Agency—Applied Designs Adv. Ltd.
Chapman & Hall Ltd. 30
Chatwin, Thomas, & Co. 140
Agency—A. N. Holden & Co. Ltd.
Chinn, J. S., & Co. Ltd. —
Churchill, Charles, & Co. Ltd. 99
Agency—Technical Advertising Service Ltd.
Churchill Machine Tool Co. Ltd., The —
Agency—Associated British Machine Tool Makers Ltd.
Clarkson (Engineers) Ltd. —
Agency—Nicholls, Dorrity Adv. Ltd.
Clayton-Wright, Howard Ltd. 22
Agency—Don Earl Publicity Ltd.
Colt Ventilation Ltd. —
Agency—Greenlys Ltd.
Consolidated Pneumatic Tool Co. Ltd. —
Agency—Crane Publicity Ltd.
Coppier Fratelli 17
Coulthard, Wm. & Company Ltd. —
Cradley Boiler Co. Ltd. —
Agency—Riley Advertising Ltd.
Crofts (Engineers) Ltd. 80
Cronite Foundry Co. Ltd., The —
Crowthorn Engineering Co. Ltd. 52
Agency—J. K. Clayton Advertising Ltd.

Dart Spring Co. Ltd. —
Agency—Beardmore Adv. Ltd.
Darwins Ltd. 67
Agency—Apex Advertising Ltd.
Dawson Bros. Ltd. —
Agency—Collinson's Adv. Agency Ltd.
Delapena & Son Ltd. —
Agency—S. D. Toon & Heath Ltd.
Dick, R. & J., Ltd. —
Agency—Rex Publicity Ltd.

Eagle Pencil Co. —
Agency—Saward Baker & Co. Ltd.
Elcontrol Ltd. 155
Agency—Fdk. E. Potter Ltd.
Electrical Development Association —
Agency—Mather & Crowther Ltd.
Electric Resistance Furnace Co. Ltd. —
Agency—Nigel Rainbow & Partners Ltd.
Electrical Power Engineering Co. (B'ham) Ltd. 56
Agency—Nicholls, Dorrity Advertising Ltd.
Electro-Dynamic Construction Co. Ltd. 41
Agency—J. Peers & Associates Ltd.
Elliott, B. (Machinery) Ltd. 130
Agency—Nigel Rainbow & Pnrs Ltd.
Elliott, E., Ltd. 64
Agency—Sterling Advertising Ltd.
Empyrium Welding & Mfg. Co. Ltd. 62
Agency—Jack White & Assocs. Ltd.
Engineering Materials & Design Exhibition 20
Agency—F. John Roe Ltd.
English Electric Co. Ltd., The 135
Agency—Technical Advertising Service Ltd.
English Steel Tool Corporation 25
Agency—T.G.A. Ltd.
E.N.V. Engineering Co. Ltd. —
Agency—Allardyce Palmer Ltd.
Evertaut Ltd. 63
Agency— Elliott Adv. Ltd.

Fafnir Bearing Co. 110
Agency—H. Raymond Morgan
Fel-Electric Ltd. —
Agency—Oelrichs Advertising Ltd.
Felco Hoists Ltd. —
Agency—Clinton-Wall Ltd.
Fenner, J. H., & Co. Ltd. —
Agency—Hyde & Partners Ltd.
Fenton, Byrn & Co. Ltd. —
Agency—J. Peers Associates Ltd.
Firth-Derihon Stampings Ltd., The 44
Agency—Stanley D. Dickson
Firth, Thos., & John Brown Ltd. 74
Agency—Stanley D. Dickson
Flame Hardeners Ltd. —
Flexello Castors & Wheels Ltd. —
Agency—Dudley Turner & Vincent Ltd.
Ford Motor Co. Ltd. 45
Agency—Rumble Crowther & Nicholas Ltd.
Fraser, Andrew, & Co. Ltd. Cover 2
Agency—J. Peers and Associates Ltd.
Fry's Metal Foundries Ltd. —
Agency—Max Ritson & Partners Ltd.

Gas Council, The 36 & 37
Agency—C. P. Wakefield Ltd.
Gear Grinding Co. Ltd. 61
Agency—Sandbrook Metcalfe & Co. Ltd.
General Electric Co. Ltd. —
Agency—Kingscott Ltd.
Glacier Metal Co. Ltd. 35
Agency—Notley Advertising Ltd.
Gloucester Foundry Ltd. 152
Agency—Print for Industry Ltd.
Goodman, George, Ltd. —
Agency—John Mitchell & Partners Ltd.
Goodyear Tyre & Rubber Co. (G.B.) Ltd., The —
Agency—Erwin Wasey Ruthrauff & Ryan Ltd.
G.P.A. Tools & Gauges Ltd. —
Griffiths, Gilbert, Lloyd & Co. Ltd. 142
Agency—Nicholls, Dorrity Advertising Ltd.
Guest, Keen & Nettlefolds (Midlands) Ltd. —
Agency—Notley Advertising Ltd.

Hackbridge & Hewittic Electric Co. Ltd. 68
Agency—Industrial Publicity Service Ltd.
Haddon, Thomas, & Stokes Ltd. —
Hadfields Ltd. —
Hallmac Tools Ltd. 4 & 5
Agency—Jack White & Associates
Hancock & Co. (Engineers) Ltd. 15
Agency—Tibbenham Publicity Ltd.
Harcourt, David, Ltd. —
Agency—Allardyce Palmer Ltd.
Hardy Spicer Ltd. 48
Agency—Central News Ltd.
Harper, John, & Co. Ltd. —
Agency—Rowlinson-Broughton Ltd.
Harris Tools, John, Ltd. —
Agency—Sandbrook, Metcalf & Co. Ltd.
Harvey, G. A., & Co. (London) Ltd. —
Agency—G. P. Hughes Ltd.
Hawker Siddeley Brush Turbines Ltd. 156
Agency—G. Street & Co. Ltd.
Heap, Joshua, & Co. Ltd. —
Heenan & Froude Ltd. 69
Agency—Kenley Advertising Ltd.
Herbert, Alfred, Ltd. 65
Hermetic Rubber Co. Ltd. 153
Hibon, G. 19
Hilger & Watts Ltd. 143
Agency—Crane Publicity Ltd.
Hoffmann, Mfg. Co. Ltd., The 43

New designs and ...

new
standards of
RELIABILITY
& PERFORMANCE

are embodied in the latest range of
ELSTREE Worm Reduction Gears by
S. E. OPPERMAN LIMITED.

Almost a century of experience in the design and manufacture of Power Transmission Equipment is packed into every ELSTREE Gear Box. By constantly anticipating the needs of Industry, S. E. OPPERMAN LIMITED have always maintained their lead as specialists in this field. Now, with a new design range, new standards of reliability and performance, and the backing of a nation-wide Technical Sales Force, they are able to offer unequalled service and to provide a range of Units to cover all conceivable applications.

The Worm Reduction Gear Box illustrated has been specially designed for liquid agitation. Features of this Box are wide spacing between bearings to allow for long unsupported impeller shafts and a bottom bearing specially designed to prevent oil seepage down the shaft. Further details on request.

ELSTREE dependable WORM REDUCTION GEARS

Whatever the nature of your problem, we shall always be happy to advise you on the most efficient transmission installation at the most economical cost. Please write or telephone our Sales Director for immediate attention to your enquiries.

SEO

S. E. OPPERMAN LTD.

BOREHAM WOOD, HERTS. ELSTREE 2021. Part of E. V. Industrials Group

Index (*continued*)

Holden, Arthur, & Sons Ltd. 148
Agency—S. D. Toon & Heath Ltd.
Holroyd, John, & Co. Ltd. —
Agency—C. R. Casson Ltd.
Horstmann Gear Co. Ltd., The 50
Agency—Trowbridge Pritchard & Co. Ltd.

I.C.I. (Plastics) Ltd. 160
Agency—S. H. Benson
Ideal Fabbrica Italiana Trapani 154
Ingersoll-Rand Co. Ltd. 58 & 59
Agency—J. Peers & Associates Ltd.
Intermit Limited 33
Agency—Central News Ltd.
Isopad Ltd. 155
Agency—E. W. Barney Ltd.

Jenkins, Robert, & Co. Ltd. 46
Agency—W. Hopwood & Co. Ltd.
Jerguson Tress Gauge & Valve Co. Ltd. —
Agency—J. Peers & Associates Ltd.
Jet-Lube Ltd. 12
Johnson Foster, H., Ltd. 136
Agency—Pickersgill Publicity Service Ltd.
Johnson Precision Instruments (Newman Granger) Ltd. 18
Agency—Rex Publicity Service Ltd.
Jones A. A. & Shipman Ltd. 66
Agency—Sterling Advertising Ltd.

Kayser, Ellison, & Co. Ltd. —
Agency—Stowe & Bowden Ltd.
Keelavite Hydraulics Ltd. 23
Agency—Cogent Advertising Service Ltd.
Kendall & Gent Ltd. 40
Agency—Associated British Machine Tool Makers Ltd.
Kenilworth Manufacturing Co. Ltd. —
Agency—Crossley & Co. Ltd.
Klaxon Ltd. —
Agency—John Mitchell & Partners Ltd.

Lang Pneumatic Ltd. —
Agency—J. Peers and Associates Ltd.
Laycock Engineering Ltd. —
Agency—Central News Ltd.
Lewis Spring Co. Ltd., The —
Agency—Longleys & Hoffmann Ltd.
Lewis & Tylor Ltd. —
Agency—Glovers Advertising Ltd.
Ley's Malleable Castings Co. Ltd. —
Agency—H. Raymond Morgan
Lincoln Electric Co. Ltd. 57
Agency—London Press Exchange Ltd.
Lodge Plugs Ltd. 126
Agency—Elliott Advertising Ltd.

Magnetic Valve Co. Ltd., The 47
Agency—John Westwood Ltd.
Meddings, W. J., Ltd. 146
Agency—Ripley, Preston & Co. Ltd.
Mercedes-Benz —
Mercer, Thos. (Air Gauges), Ltd. —
Agency—Nigel Rainbow & Partners Ltd.
Midland Industries Ltd. 138
Agency—A. A. Black Ltd.
Mirrlees, Bickerton & Day Ltd. —
Agency—Rowlinson-Broughton Ltd.
Mobil Oil Co. Ltd. 100
Agency—Masius & Ferguson Ltd.
Mond Nickel Co. Ltd. —
Agency—T.G.A. Ltd.
Monks & Crane Ltd. 2
Agency—Sandbrook, Metcalf & Co. Ltd.
Morgan Crucible Co. Ltd., The 60
Morris, B. O., Ltd. —
Agency—Cogent Advertising Service Ltd.
Mountford, Frederick (B.ham) Ltd. —
Agency—S. D. Toon & Heath Ltd.
Mullard Equipment Ltd. —
Agency—Roles & Parker Ltd.

Nash & Thompson Ltd. 108
Agency—Jas. Sutherland Publicity Ltd.
Neill, James, & Co. (Sheffield) Ltd. 106
Agency—J. K. Clayton Adv. Agency Ltd
Newall, A. P., & Co. Ltd. —
Agency—Osborne-Peacock Co. Ltd.
Newall Group Sales Ltd. —
Agency—J. Peers and Associates Ltd.
Newbold & Bullford Ltd. —
Agency—Hatton Press Ltd.
Newton Chambers & Co. Ltd. 145
Agency—F. C. Pritchard Wood & Pnrs. Ltd.
Nitralloy Ltd. 152
Agency—Stanley D. Dickson
North British Rubber Co. Ltd. —
Agency—Robert Freeman & Co. Ltd.
Nu-Way Heating Plants Ltd. —
Agency—Sinclair Advertising Ltd.

Opperman Gears Ltd. 11
Agency—Ripley Prestona Co. Ltd.
Opperman, S. E. Ltd. 158
Agency—Erwoods Ltd.
Osborn, Samuel, & Co. Ltd. —
Ozalid Co. Ltd. 104
Agency—Oatley Webster Ltd.

P.R. Motors Ltd. —
Agency—A. A. Black Ltd.
Parmiter, Hope & Sugden Ltd. 14
Agency—Donald Macdonald (Advertising) Ltd.
Perry Barr Metal Co. Ltd. —
Agency—Tom C. Gough and Partners Ltd.
Pioneer Oilsealing & Moulding Co. Ltd. 42
Agency—Hyde & Partners Ltd.
Pitman, Sir Isaac, & Sons Ltd. 3
Podmores (Engineers) Ltd. 149
Agency—Maurice & Parker Ltd.
Pollard Bearings Ltd. —
Agency—Hedley, Byrne & Co. Ltd.
Powder Couplings Ltd. 132
Agency—Dryden-Allen Ltd.
Power-Gas Corporation Ltd. —
Pyrene Co. Ltd., The 6
Agency—Nelson Adv. Service Ltd.

Ransome & Marles Bearing Co. Ltd. —
Agency—Ruddocks Advertising Agency
Refined Iron Co. (Darwen) Ltd. 139
Agency—Stowe & Bowden Ltd.
Renold Chains Ltd. —
Richards, Charles, & Sons Ltd. 16
Agency—Longleys & Hoffmann Ltd.
Roberts, J. W., Ltd. 114
Agency—Armstrong-Warden Ltd.
Robinson, L., & Co. (Gillingham) Ltd. 154
Agency—Ripley Preston & Co. Ltd.
Rockwell Machine Tool Co. Ltd. 70
Agency—John Mitchell & Partners Ltd.
Rocol Ltd. —
Agency—Nevin D. Hirst (Advertising) Ltd.
Rotameter Mfg. Co. Ltd. 151
Agency—Geoffrey Dadd Ltd.
Rotherham & Sons Ltd. 154
Agency—George Murray Advertising Ltd.
Royce Electric Furnaces Ltd. 134
Agency—Nigel Rainbow & Partners
Rubert & Co. Ltd. 26
Ryder Thos., & Son Ltd. 49
Agency—W. S. Crawford Ltd.

Salter, Geo. & Co. Ltd. —
Agency—Severn Publicity Ltd.
Sanderson, Bros. & Newbould Ltd. 147
Saturn Industrial Gases Ltd. —
Agency—Crossley & Co. Ltd.
Savery, Thomas, Pumps Ltd. —
Agency—Boswell, Barrett & Phillips Ltd.
Self-Changing Gears Ltd. —
Serck Radiators Ltd. 31
Agency—Longleys & Hoffmann Ltd.
Sheffield Twist Drill & Steel Co. Ltd., The 53
Sintered Products Limited —
Agency—W. S. Crawford Ltd.
Slack & Parr Ltd. 144
Agency—Rex Publicity Service Ltd.
Smith, S., & Sons (England) Ltd. 7
Agency—Allardyce Palmer Ltd.
Smiths Motor Accessory Division 149
Agency—Masius & Ferguson Ltd.
Southern Instruments Ltd. 124
Agency—Brandis Davis Agency Ltd.
Sperry Gyroscope Co. Ltd. —
Agency—Samson Clark & Co. Ltd.
Standard Piston Ring Co. Ltd. 78
Agency—H. C. Boulter Publicity Ltd.
Standard Telephones & Cables Ltd. —
Agency—Brockie Haslam & Co.
Steel, J. M., & Co. Ltd. —
Agency—Reynell & Son Ltd.
Sterling Metals Ltd. —
Agency—T. G. Scott & Son Ltd.
Stone-Wallwork Ltd. 21
Agency—Holman Advertising Ltd.
Super Oil Seals & Gaskets Ltd. —
Agency—A. A. Black Ltd.
Sykes, W. E., Ltd. 55
Agency—W. S. Crawford Ltd.

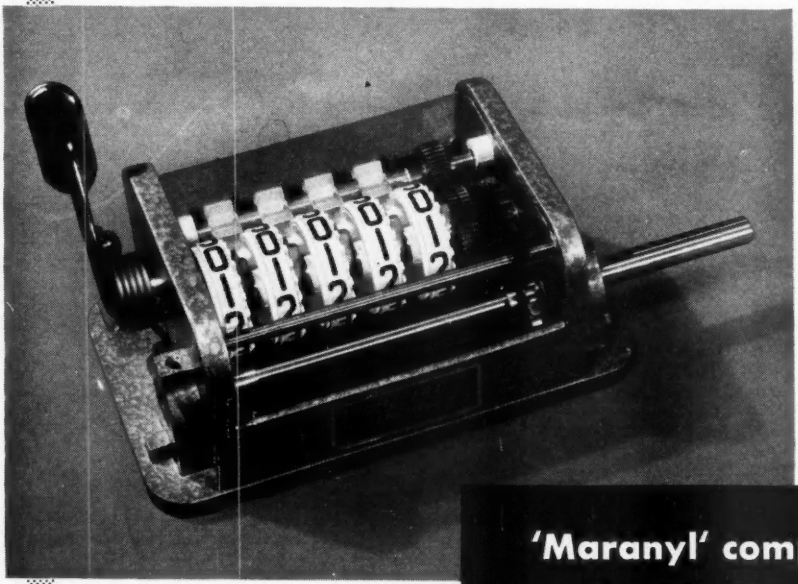
Tangyes Limited —
Taylor Bros., & Co. Ltd. —
Technical Applications Ltd. 122
Agency—Alfred Bates & Son Ltd.
Teddington Industrial Equipment Ltd. —
Agency—Crane Publicity Ltd.
Terry, Herbert & Sons Ltd. 116
Agency—John Haddon & Co. Ltd.
Thorp, Thomas, & Co. Ltd. 144
Agency—J. Peers & Assoc. Ltd.
Thorpe, F. W., Limited Cover 3
Agency—S. D. Toon & Heath Ltd.
Titanium Metal & Alloys Ltd. 142
Agency—Alfred Bates & Son Ltd.
Torrington Co. Ltd., The —
Agency—Osborne Peacock Co. Ltd.
Tress Engineering Co. Ltd. —
Agency—J. Peers & Associates Ltd.

United Coke & Chemicals Co. Ltd. 132
Agency—Rowlinson-Broughton Ltd.
United Dominions Trust (Commercial) Ltd. 120
gency—St. James Adv. & Publicity Co. Ltd.
United States Metallic Packing Co. Ltd. —
Agency—Wm. Furness Ltd.
Uni-Tubes Ltd. —
Agency—Frederick Aldridge Ltd.

Varatio-Strateline Gears Ltd. 78
Agency—Thomas G. Birtles Ltd.
Vaughan, Edgar, & Co. Ltd. —
Agency—Oldfield & Sharp
Vickers Armstrong (Engineers) Ltd. 137 & 146
Agency—T.G.A. Ltd.
Victor Products (Wallsend) Ltd. 152
Agency—Doig Advertising Ltd.
Vokes Ltd. 131
Agency—Crane Publicity Ltd.

Waircom 54
Wakefield-Dick Industrial Oils Ltd. —
Agency—Dorland Adv. Ltd.
Walker, Crosweller & Co. Ltd. 112 & 118
Agency—Beardmore Advertising Ltd.
Walpamur Co. Ltd., The 141
Agency—Osborne-Peacock Co. Ltd.
Ward (Metal Details) Ltd. 148
Agency—Beardmore Advertising Ltd.
Welconstruct Co. Ltd. 150
Agency—Mundy, Gilbert & Troman Ltd.
Wellworthy Ltd. —
Agency—Erwin Wasey, Ruthrauff & Ryan Ltd.
Wharton Crane & Hoist Co. Ltd. 38
Agency—Henry Pybus Ltd.
Whitehouse Industries Ltd. —
Agency—Hedley Byrne & Co. Ltd.
Wiggin, Henry, & Co. Ltd. —
Agency—T.G.A. Ltd.
Wild-Barfield Electric Furnaces Ltd. —
Agency—Crane Publicity Ltd.
Williams, John, of Cardiff Ltd. 150
Agency—Glovers Adv. Ltd.
Wolverhampton Diecasting Co. Ltd., The —
Agency—Sterling Advertising Ltd.
Woodside Die Sinking Co. Ltd. —
Agency—F. C. Pritchard Wood & Partners Ltd.

Today's engineers are using the material of tomorrow — 'Maranyl' A 100 nylon



'Trumeter' counter made by Trumeter Co. Ltd., Radcliffe, Manchester, incorporating components moulded in 'Maranyl' A 100 nylon.

'Maranyl' components make this 'Trumeter' counter tough, quiet, long lasting.

THIS 'TRUMETER' counter, made by Trumeter Co. Ltd., Radcliffe, Manchester, incorporates components moulded in 'Maranyl' A 100 nylon. These components are tough, long-lasting and need no lubrication. Because of 'Maranyl' A 100 nylon, the counter is silent in operation and it resists vibrational fatigue.

There are many other important features of this I.C.I. plastic that commend it for a multitude of uses in the industry of today—and tomorrow. It resists oils, fuels, greases and most common solvents. It has good electrical properties (it is non-tracking). It is shock resistant, easy to fabricate and is available in a wide range of colours.

I.C.I. RESEARCH AND TECHNICAL SERVICE

'Maranyl' A 100 nylon is backed by the full force of I.C.I. Research and Technical Service. That service is available to you. If there is anything you wish to know about nylon and its uses; if you have a problem concerning noise, lubrication, wear and durability—consult I.C.I. They will be glad to help.

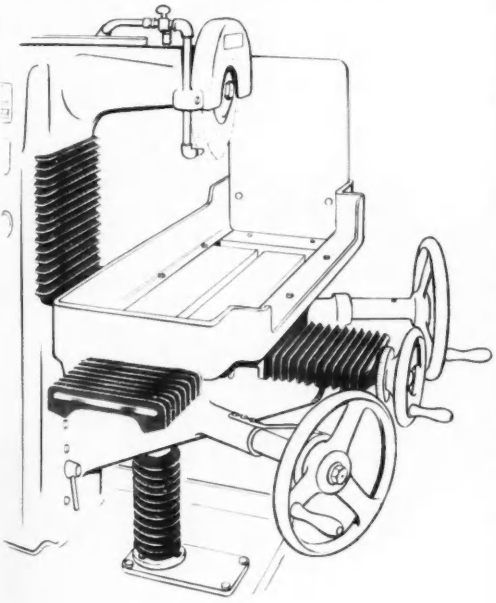
'Maranyl' A 100 NYLON

'Maranyl' is the registered trade mark for the nylon compounds manufactured by I.C.I.

PN17

IMPERIAL CHEMICAL INDUSTRIES LIMITED · LONDON · S.W.1

Protection - made to measure



Fortox Flexible Covers are designed and manufactured specifically to fit any part of a machine requiring protection. Single items can be supplied promptly, usually without tool charge. Made in neoprene-nylon, proofed leather or coated fabrics, according to conditions, Fortox Covers exclude dirt from sliding members, cutting down wear, reducing maintenance and lengthening the life of a machine. Write now for our technical book 'The Design and Use of Corrugated Covers'.

Ask also about Fortox Leather Seals and Packings made to requirements. A range of high accuracy polyester, silicone or synthetic rubber impregnated leathers is available to ensure positive sealing over a wide variety of conditions.

FORTOX seals and packings

FORTOX flexible covers

HENRY BEAKBANE (FORTOX) LTD.

Head Office:
THE TANNERY, STOURPORT-ON-SEVERN, WORCS.
Tel. Stourport 2017. Grams: Beakbane, Stourport.

London Office:
28-30 LITTLE RUSSELL STREET, LONDON, W.C.1
Tel. Holborn 7295. Grams: Beakbane, Westcent, London.

High efficiency **DEMANDS** efficient lighting

The Thorlux 'Flexaflor' twin 8 watt Bench Light is an exceptionally robust piece of equipment, but with its grey hammered enamel finish, it's attractive too.

Its many features include a base to house the control gear, suitable for wall and bench mounting. The perspex front cover—opal or clear—simply slides out for cleaning and relamping.

Above all, this new 'Flexaflor' is a thoroughly practical Bench Light which provides a cool shadowless illumination for exacting work.

If you'd like to know more, you only have to ask us.

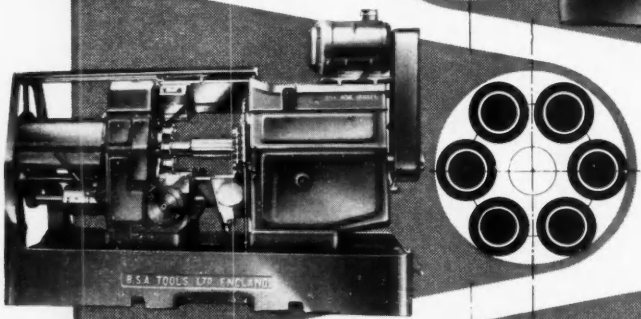
THORLUX REGD. THROWS LIGHT ON INDUSTRY

FLEXAFLOR TWIN 8 WATT **BENCH LIGHT**

F. W. THORPE LIMITED
WELBY RD., HALL GREEN, BIRMINGHAM, 28.
Telephone: SPRingfield 3318 (3 lines)

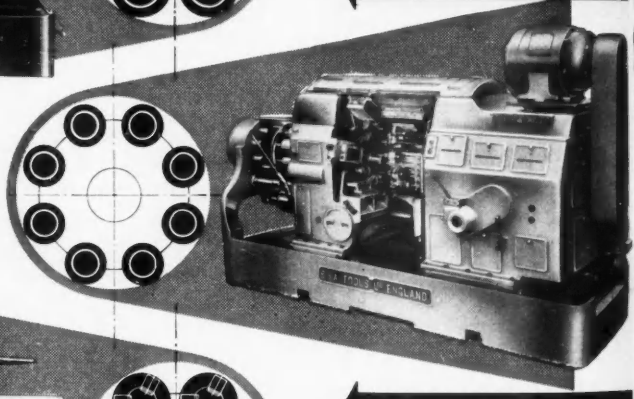
B·S·A ACME-GRIDLEY

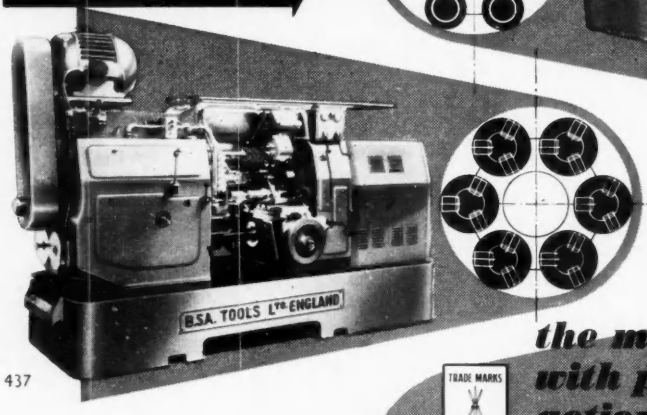
BAR
$2\frac{1}{4}$, $3\frac{1}{2}$
FOUR SPINDLE



BAR
$\frac{7}{16}$, 1, $1\frac{1}{4}$, $1\frac{5}{8}$, $2\frac{5}{8}$
SIX SPINDLE

BAR
$1\frac{5}{8}$
EIGHT SPINDLE





CHUCKING
6"
SIX SPINDLE

437

the multi-spindle autos with positive direct-action quick-change cam control

TRADE MARKS
B·S·A TOOLS GROUP

MAKERS:
B.S.A. TOOLS LTD · BIRMINGHAM · 33
ENGLAND

SOLE AGENTS GT BRITAIN BURTON GRIFFITHS & CO LTD KITTS GREEN BIRMINGHAM STECHFORD 3071

5/11
8

tos

3071